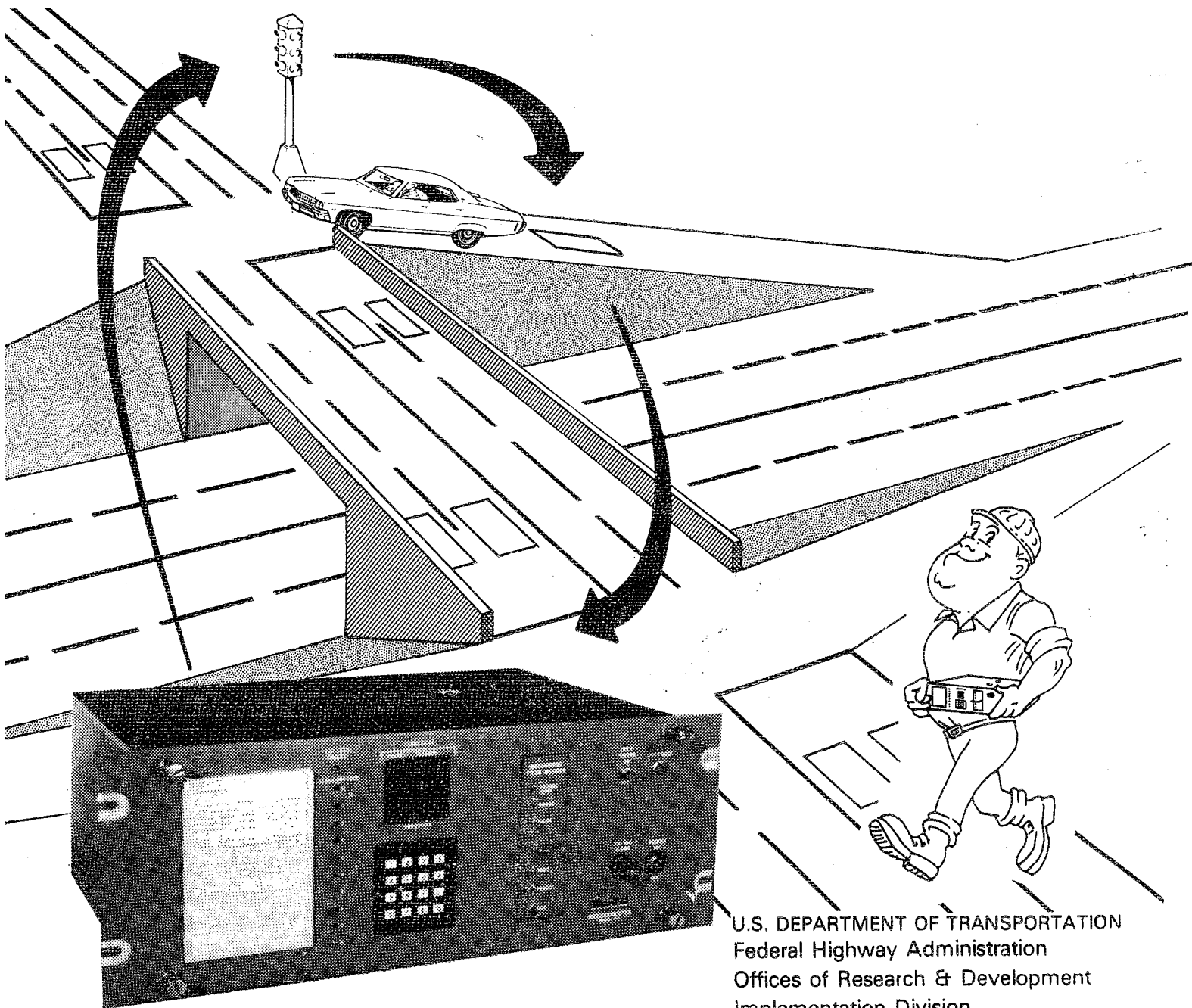


54/1  
The California/New York

FHWA-IP-78-16  
DECEMBER 1978

# Type 170 Traffic Signal Controller System – Hardware Specification



U.S. DEPARTMENT OF TRANSPORTATION  
Federal Highway Administration  
Offices of Research & Development  
Implementation Division

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TYPE

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The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein only because they are considered essential to the object of this document.

## PREFACE

This document is a copy of the California/New York Type 170 Traffic Signal Controller System Hardware Specification. It is for your information and use. California and New York believe that it allows interchangeability of products between manufacturers. They state advantages of cost effectiveness and flexibility.

There are a variety of prerequisites a jurisdiction should meet before using this specification. First, you should have a competent traffic engineering staff. Second, you should have competent traffic signal and electrical technician staff. Third, you should have, or have access to, an environmental test chamber for performing acceptance testing. This requirement is ideal and should apply to all controllers, not the 170 alone. Fourth, you should recognize that the standard software packages are flexible but if you wish "toots and whistles" not presently available that these will be expensive. Fifth, the use of micro computer controllers does not reduce the need for an adequately equipped signal repair shop. Sixth, California and New York purchase the equipment on contracts separate from the installation contracts. This practice may or may not be suitable for your jurisdiction and you may wish to modify it. Seventh, California and New York program their own software. Your jurisdiction may wish to specify that the vendor supply properly functioning California/New York software in the controller or you may wish to program it yourself. If the latter, a familiarity with microcomputer programming is required.

The Implementation Division of the FHWA Office of Research and Development intends to publish the users manuals and program documentation for Type 170 System control programs from California after each is extensively field tested. The first two documents to follow this one will be Local Intersection Program (fixed time, fully actuated, traffic responsive). and Diamond Interchange Program (fixed time, fully actuated, traffic responsive). Planned later documents will cover arterial control, acceptance testing, maintenance and diagnostics.

Comments and suggestions by user, consultants and vendors are solicited.

The Federal Highway Administration gratefully recognizes the following organizations for their significant contributions to this project.

California Department of Transportation

New York Department of Transportation

City of Jacksonville, Florida

**TRAFFIC SIGNAL CONTROL  
EQUIPMENT SPECIFICATIONS**



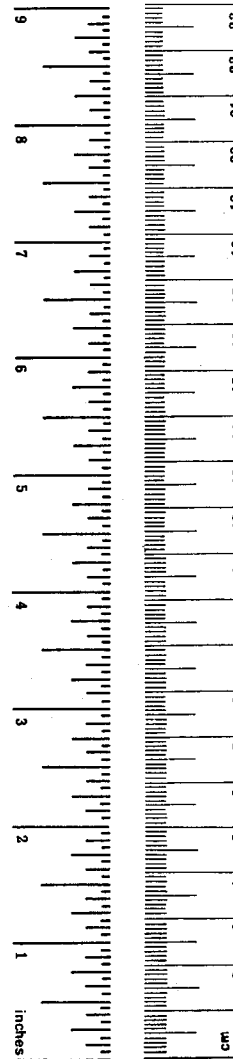
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# METRIC CONVERSION FACTORS

## Approximate Conversions to Metric Measures

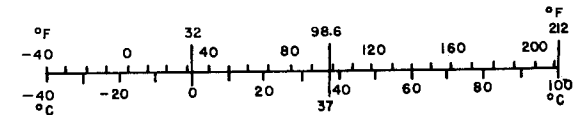
Symbol	When You Know	Multiply by	To Find	Symbol
<b>LENGTH</b>				
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
<b>AREA</b>				
in <sup>2</sup>	square inches	6.5	square centimeters	cm <sup>2</sup>
ft <sup>2</sup>	square feet	0.09	square meters	m <sup>2</sup>
yd <sup>2</sup>	square yards	0.8	square meters	m <sup>2</sup>
mi <sup>2</sup>	square miles	2.6	square kilometers	km <sup>2</sup>
	acres	0.4	hectares	ha
<b>MASS (weight)</b>				
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
<b>VOLUME</b>				
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft <sup>3</sup>	cubic feet	0.03	cubic meters	m <sup>3</sup>
yd <sup>3</sup>	cubic yards	0.76	cubic meters	m <sup>3</sup>
<b>TEMPERATURE (exact)</b>				
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

\*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price \$2.25, SO Catalog No. C13.10:286.



## Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
<b>LENGTH</b>				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
<b>AREA</b>				
cm <sup>2</sup>	square centimeters	0.16	square inches	in <sup>2</sup>
m <sup>2</sup>	square meters	1.2	square yards	yd <sup>2</sup>
km <sup>2</sup>	square kilometers	0.4	square miles	mi <sup>2</sup>
ha	hectares (10,000 m <sup>2</sup> )	2.5	acres	
<b>MASS (weight)</b>				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
<b>VOLUME</b>				
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m <sup>3</sup>	cubic meters	35	cubic feet	ft <sup>3</sup>
m <sup>3</sup>	cubic meters	1.3	cubic yards	yd <sup>3</sup>
<b>TEMPERATURE (exact)</b>				
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



## **CHAPTER 1**

### **GENERAL SPECIFICATIONS FOR TRAFFIC SIGNAL CONTROL EQUIPMENT**



GENERAL SPECIFICATIONS FOR  
TRAFFIC SIGNAL CONTROL EQUIPMENT

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SPECIFICATIONS FOR  
TRAFFIC SIGNAL  
CONTROL EQUIPMENT

SCOPE

This Chapter defines the general requirements applicable to equipment used for traffic signal control.

SECTION I

GLOSSARY

1. Wherever in these specifications the following terms or abbreviations are used, the intent and meaning shall be interpreted as follows:

AC+ - 120 Volt AC, 60 Hertz Ungrounded Power Source

AC- - 120 Volt AC, 60 Hertz Grounded Return to the Power Source

ACIA - Asynchronous Communications Interface Adaptor

Cabinet - An outdoor enclosure for housing the controller unit and associated equipment

Controller Unit - That portion of the controller assembly devoted to the selection and timing of traffic movements

Contractor - The person or persons, firm, partnership, corporation, or combination thereof, who have entered into a contract with the STATE, as party or parties of the second part of his or their legal representative

CR - Control Register

DTA - Down Time Accumulator

EIA - Electronic Industries Association

Engineer - The Chief Engineer acting either directly or through properly authorized agents, such agents acting within the scope of the particular duties delegated to them.

LED - Light Emitting Diode

MODEM - Modulate/Demodulate Unit

MOS - Metal Oxide Semiconductor

MPU - Microprocessor Unit

NA - Not Assigned, cannot be used

NC - Not connected

NEMA - National Electrical Manufacturer's  
Association

Power Failure - Incoming Line Voltage falls below  
95 Volts, AC. for 50 milliseconds  
or more

PROM - Programmable Read Only Memory

RAM - Random Access Memory

RDR - Receiver Data Register

SR - Status Register

State - State of California

TDR - Transmit Data Register

TTL - Transistor Transistor Logic

UL - Underwriter's Laboratories, Inc.

## SECTION II

### GENERAL

1. All equipment furnished under these specifications shall be of the solid state design. The use of vacuum or gaseous tubes or electromechanical devices within the equipment is not acceptable unless otherwise indicated.
2. The requirements in Chapter 1 are applicable to all equipment supplied unless otherwise indicated.
3. Two manuals shall be supplied for each item required under the contract. Three preliminary copies of the manual shall be supplied for approval prior to final printing. Each manual shall include the following:
  - a) General Description
  - b) General Characteristics
  - c) Installation
  - d) Adjustments
  - e) Theory of operation
    1. Systems Description (Include block diagram).
    2. Detailed Description of Circuit Operation.
  - f) Maintenance
    1. Preventive Maintenance.
    2. Trouble Analysis.
    3. Trouble Shooting Sequence Chart.
    4. Wave Forms.
    5. Voltage Measurements.
    6. Alignment Procedures.
  - g) Parts List (to include circuit and board designation, part type and class, power rating and component manufacturer)
  - h) Electrical Interconnection Drawing
  - i) Schematic and Logic Diagram
  - j) Assembly Drawings and a Pictorial Diagram Showing Physical Locations and Identification of Each Component.
4. Interchangeability

The following assemblies in the cabinet shall electrically and mechanically intermate with the following associated devices:

## Assemblies

## Associated Devices

Output File	Model 200 Switch Pack Model 210 Monitor Unit Flash Transfer Relays, Model 430
Input File	Models 222, 224, 228, 232, 234 Detectors Models 242 and 244 Isolators
Power Distribution Assembly	Model 204 Flasher Unit Transfer Relay, Model 430
Output/Power Distribution Assembly (Model 334 Cabinet)	Model 200 Switch Pack Transfer Relay, Model 430
Auxiliary Output File, Model 420	Model 200 Switch Pack Flash Transfer Relays, Model 430

The Model 170 Controller Unit shall be compatible with and intermate to Controller Cabinet Models 330, 332 and 334.

### 5. Indicators and Character Displays

5.1 All indicators and character displays shall have a cone of visibility of  $\pm 60$  degrees from an axis perpendicular to the front panel. All indicators and character displays shall be readily visible at a radius of up to 4 feet within the cone of visibility when the indicator is subjected to 9,000 footcandles of white light with the light source at 45 degrees to the front panel. If characters are not self-luminous, illumination shall be provided for viewing in low levels of ambient light.

5.2 All indicators and character displays with a rated life below 100,000 hours shall be replaceable from the front of the equipment.

### 6. Electrical connections to and from all equipment shall be in accordance with the detailed specifications, and the following:

6.1 All connectors shall be keyed to prevent accidental insertion of the wrong connector or printed circuit card.

6.2 Printed circuit card edge connectors shall have bifurcated gold plated contacts.

- 6.2.1 The printed circuit connector shall meet or exceed the following:

Operating Voltage: 600 VAC (RMS)  
at sea level

Current Rating: 5 amperes

Insulation Resistance: 5,000 megohms

Contact Material: Copper alloy plated with  
0.000005 inches of nickel  
and 0.000015 inches of gold

Contact Resistance: 0.006 ohms

- 6.3 All pin and socket connectors furnished shall use the AMP #601105-1 or #91002-1 contact insertion tool, and the AMP #305183 contact extraction tool.
- 6.4 Pin and socket contacts shall be beryllium copper construction subplated with 0.00005-inch nickel and plated with 0.00003-inch gold. Pin diameter shall be 0.062-inch.
- 6.5 All connector pins called out as unassigned shall not be used.
7. Each delivered item shall be individually packaged in its own shipping container.
8. Each delivered item shall be complete, ready for testing.

### SECTION III

#### COMPONENTS

1. No component shall be of such design, fabrication, nomenclature, or other identification as to preclude the purchase of said component from a wholesale electronics distributor, or from the component manufacturer, except as noted.
  - 1.1 When monolithic integrated circuits are of such special design that they preclude the purchase of identical components from any wholesale electronics distributor or component manufacturer, one exact duplicate monolithic integrated circuit shall be furnished with each twenty, or fraction thereof, monolithic integrated circuits used.
2. Electronic components shall not be socket or jack mounted, except that large scale integrated (LSI) circuits having 16 or more leads shall be socket or jack mounted.
3. Electrolytic capacitors shall not be used for capacitance values of less than 1.0 microfarad.
4. All discrete components, such as resistors, capacitors, diodes and transistors, and integrated circuits shall be individually replaceable. Components shall be arranged so they are easily accessible for testing and maintenance.
5. All components shall be downrated by 20 percent with regard to applied voltage and power dissipation so that material shortening of life or shift in values is minimized.
6. The design life of all components, under 24 hours a day operating condition in their circuit application, shall be not less than ten years.
7. The circuit reference symbol for each component part shall be clearly marked.
8. Encapsulation of two or more discrete components into circuit modules is prohibited, except for transient suppression circuits and resistor packs.

9. The State, at its option, may require the Contractor to submit detailed engineering technical data on any component part. A letter from the component manufacturer shall be submitted with the detailed engineering data when the proposed application of the component alters the technical data. The letter shall certify that the component application meets specification requirements.

## 10. Capacitors

- 10.1 The D.C. and A.C. voltage ratings as well as the dissipation factor of a capacitor shall meet the worst case design parameters of the circuitry.
- 10.2 The effect of change in capacitance due to environmental changes shall not cause circuit malfunctions.
- 10.3 A capacitor which may be damaged by shock or vibration shall be supported mechanically by a clamp or fastener.
- 10.4 Capacitor encasements shall be resistant to cracking, peeling and discoloration due to humidity and changes in temperature.
- 10.5 All capacitors shall be insulated and shall be marked with their capacitance value, working voltage and, when applicable, indicate polarity or outer foil.

## 11. Potentiometers

- 11.1 Potentiometers with ratings from one to two watts shall be the commercial equivalent of Military Type RV4.
- 11.2 Potentiometers (excluding trimmer type potentiometers) of less than one watt rating shall not be used.
- 11.3 The power rating of any potentiometer shall be at least 100 percent greater than the maximum power requirements of the circuit.

## 12. Resistors

- 12.1 Fixed carbon film, deposited carbon, or composition insulated resistors shall conform to the performance requirements of Military Specifications: MIL-R-11 or MIL-R-22684.



12.1.1 All resistors shall be insulated and shall be marked with their resistance value. Resistance values may be indicated by the EIA color codes.

12.2 Resistors shall be 10 percent or less tolerance.

12.3 The value of the resistors shall not vary by more than 5 percent between  $-37^{\circ}\text{C}$  and  $+74^{\circ}\text{C}$ .

12.4 No resistors of a rating exceeding two watts shall be used unless special ventilation or heat sinking is provided. When used they shall be insulated from the printed circuit board.

### 13. Semiconductor Devices

13.1 Semiconductor devices shall not be stressed to more than 80 percent of any of their design ratings.

13.4 All solid state devices, except LED's shall be of the silicon type, except as noted herein.

13.5 All transistors, integrated circuit, and diodes shall be a standard type listed by EIA and clearly identifiable to this standard, except as noted.

13.6 When permitted in writing by the Engineer, germanium diodes may be used only when a low forward voltage drop is required in logic circuit applications.

13.7 All metal oxide semiconductor components shall contain circuitry to protect their inputs and outputs against damage due to high static voltages or electrical fields.

13.8 Pin 1 location of all LSI sockets shall be properly marked on the board adjacent to the socket.

### 14. Transformers and Inductors

14.1 All transformers and inductors shall have the manufacturer's part number clearly and legibly printed on the case or frame.

14.2 All transformers and inductors shall have their windings insulated and shall be protected to exclude moisture. All wire leads shall be numbered, marked, or color coded.

- 14.3 All transformer and inductor leads shall be color coded with an approved EIA color code or numbered in a manner to facilitate proper installation.

## 15. Circuit Breakers

- 15.1 Circuit breakers shall be approved and listed by UL. The trip and frame size shall be plainly marked. All breakers shall be quick-make, quick-break on either manual or automatic operation. Contacts shall be silver alloy enclosed in an arc quenching chamber. Overload tripping shall not be influenced by an ambient temperature range of from  $-37^{\circ}\text{C}$  to  $+74^{\circ}\text{C}$ . Minimum interrupting capacity shall be 5,000 amperes, RMS.
- 15.2 Circuit breakers shall be the trip-free type.
- 15.3 Multi-pole breakers shall be the common-trip type.

## SECTION IV

### MECHANICAL

#### 1. Modular or Printed Circuit Design

- 1.1 Module or printed circuit board assemblies shall incorporate plug-in techniques (except for power supplies or mother boards), and be easily replaceable. To facilitate interchangeability, 2 guides shall be provided for each assembly except for relays. All assemblies shall be mechanically secured so as to retain the assemblies in their proper position under conditions of shock and vibration. No components, traces, brackets or obstructions shall be within 1/8-inch of the guide edges of the boards.
- 1.2 Guides shall extend to within 3/4-inches from the face of either the socket or connector.

#### 2. Workmanship

- 2.1 Workmanship shall be in accordance with the highest industry standards.

#### 3. Model Numbers

- 3.1 The manufacturer's model number, serial number and circuit issue or revision number shall appear on the rear panel of all equipment and modules supplied.
- 3.2 In addition to any assignment of model numbers by the manufacturer, three digits shall be displayed on the front panel in bold type, at least 1/4-inch high. The digits are supplied in the following table:

<u>DESCRIPTION</u>	<u>MODEL NO.</u>
Controller Unit	#170
Switchpack	#200
Flasher Unit	#204
Monitor Unit	#210
2 Channel Loop Detector Sensor Unit	#222
4 Channel Loop Detector Sensor Unit	#224
Magnetometer Detector Sensing Element	#227
2 Channel Magnetometer Control Unit	#228
Magnetic Detector Sensing Element	#231
2 Channel Magnetic Detector Amplifier	#232
4 Channel Magnetic Detector Amplifier	#234
2 Channel Isolator	#242

DESCRIPTIONMODEL NO.

4 Channel Isolator	#244
Cabinet, Model 330	#330
Cabinet, Model 332	#332
Cabinet, Model 334	#334
MODEM	#400
Diagnostic PROM Module	#410
Auxiliary Output File	#420
Heavy Duty Relay	#430

4. All PC Board Connectors mounted on a Mother Board shall be mechanically secured to the chassis or frame on the unit.
5. All screw type fasteners shall utilize locking devices or locking compounds except for finger screws which shall be captive.

## SECTION V

### ENGINEERING

#### 1. Human Engineering

To the highest practicable degree, the unit shall be engineered for simplicity and ease of operation and maintenance. This shall include the following specific points:

- 1.1 No more than two potentiometers, controls or switches may be mounted concentrically. Knobs for such devices shall have diameters in a ratio of 2:1 outer to inner. The outer knob shall have a diameter of at least one inch.
- 1.2 Knobs shall be of large enough diameter (at least 1/2 inch diameter) and of great enough separation (at least 1/2 inch edge to edge) to assure ease of adjustment without disturbance of adjacent knobs.
- 1.3 All fuses shall be easily accessible and shall be replaceable without the use of any tools.
- 1.4 Modules shall slide smoothly in their guides while being inserted into or removed from the frame and shall fit snugly into the plug-in printed circuit connectors.
  - 1.4.1 Modules shall require a force no less than 5 pounds or greater than 50 pounds for insertion or removal.

#### 2. Design Engineering

The following practices shall be employed in the design of solid state equipment circuitry.

- 2.1 The design shall be inherently temperature compensated to prevent abnormal operation.

The circuit design shall include such compensation as is necessary to overcome adverse effects due to temperature in the specified environmental range.
- 2.2 For reasons of personal safety, personnel shall be protected from all dangerous voltages.

## SECTION VI

### PRINTED CIRCUIT BOARDS

#### 1. Design, Fabrication and Mounting

- 1.1 All contacts on printed circuit boards shall be gold plated.
- 1.2 Printed circuit board design shall be such that components may be removed and replaced without damage to boards, traces or tracks.
- 1.3 Fabrication of printed circuit boards shall be in compliance with Military Specification: MIL-P-13949, except as follows:
  - 1.3.1 Only NEMA G-10 glass cloth base epoxy resin copper clad laminates 1/16 inch minimum thickness shall be used. Inter-component wiring shall be by laminated copper clad track having a minimum weight of 2 ounces per square foot with adequate cross-section for current to be carried. All copper track shall be plated or soldered to provide complete coverage of all exposed copper track. Jumper wires will not be permitted, except from plated-through padded holes to an external component or for designed function selection with the jumper insulated and as short as possible.
  - 1.3.2 Section 3.3.3 of Military Specification: MIL-P-13949E shall read "Pits and Dents. Grade of pits and dents shall be of Grade B quality (3.3.3.2) or better.
  - 1.3.3 Section 3.3 of Military Specification: MIL-P-13949 shall be omitted.
  - 1.3.4 Section 3.4 of Military Specification: MIL-P-13949 shall read "Warp or Twist. Class of permissible warp or twist shall be Class A (Table II) or better."
  - 1.3.5 Sections 4.2 through 6.6 of Military Specification: MIL-P-13949 (inclusive) shall be omitted except as referenced in previous sections of this specification.

1.4 The fabrication of printed circuit boards and the mounting of parts and assemblies thereon shall conform to Military Specification: MIL-STD-275, except as follows:

- 1.4.1 All semiconductor devices required to dissipate more than 250 milliwatts or any case temperature that is 10° C above ambient shall be mounted with spacers or transipads to prevent direct contact with the printed circuit board.
- 1.4.2 When completed, all residual flux shall be removed from the printed circuit board.
- 1.4.3 The resistance between any two isolated, independent conductor paths shall be at least 100 megohms when a 500 volt D.C. potential is applied.
- 1.4.4 All boards shall be coated with a moisture resistant coating.
- 1.4.5 Where less than 1/4-inch clearance is provided between the printed circuit conductors and any metal frame, a 1/16-inch plastic cover shall be provided to isolate the printed circuit conductors.

## 2. Soldering

- 2.1 Hand soldering shall comply with Military Specification: MIL-P-55110.
- 2.2 Automatic flow soldering shall conform to the following conditions:
  - a. Constant speed conveyor system.
  - b. Conveyor speed shall be the optimum to minimize solder peaks or points which form at component terminals.
  - c. Temperature shall be controlled to within  $\pm 8^{\circ}$  C of the optimum temperature.
  - d. The soldering process shall result in the complete coverage of all copper runs, joints and terminals with solder except that which is covered by an electroplating process.
  - e. Wherever clinching is not used, a method of holding the components in the proper position for the flow process shall be provided.

- f. If exposure to the temperature bath is of such a time-temperature duration as to come within 80 percent of any component's maximum specified time-temperature exposure, that component shall be hand soldered to the printed circuit board after the flow process has been completed.

### 3. Definitions

Definitions for the purpose of this specification shall be taken from Military Specification: MIL-STD-429 as amended.

- 4. Board tolerances, unless otherwise specified, shall be  $\pm 0.005$  inch.



## SECTION VII

### QUALITY CONTROL

The following measures shall be taken by the Contractor during the production process to insure a high standard of quality.

#### 1. Components

- 1.1 All components shall be lot sampled to assure a consistent high conformance standard to the design specification of the unit.

#### 2. Sub-assembly or module

- 2.1 Visual inspections shall be performed on all modules, printed circuits and sub-assemblies to determine any physical defects such as cracking, scaling, poor fastening, incorrect component values, etc.
- 2.2 Complete electrical testing shall be performed on each module, printed circuit or sub-assembly to determine its compliance to the manufacturer's design function.
- 2.3 Housing, chassis, and connection terminals shall be inspected for mechanical sturdiness and harnessing to sockets shall be electrically tested for proper wiring sequence.

#### 3. Units

- 3.1 The completely assembled unit shall be subjected to a full cycling and timing test.
- 3.2 The unit shall be visually and physically (manually) inspected to assure proper placement, mounting, and compatibility of sub-assemblies.

#### 4. Predelivery Repair

The procedures listed below shall be followed in repair of equipment before shipment.

- 4.1 Any defects or deficiencies found by the inspection system involving mechanical structure or wiring shall be fed back through the manufacturing process or special repair process for correction.

4.2 Defects in printed circuit boards or electronic circuit components shall be specially treated as follows:

- (a) A printed circuit board may be flow soldered a second time if copper runs and joints are not satisfactorily coated on the first run.
- (b) Under no circumstances shall a printed circuit board be flow soldered more than twice.
- (c) Hand soldering may be used for printed circuit repair.

## SECTION VIII

### ELECTRICAL, ENVIRONMENTAL AND TESTING REQUIREMENTS

#### 1. General

- 1.1 The general procedures and equipment used in the evaluation of the controller unit, cabinet and auxiliary equipment are a minimum guide and should not limit the testing and inspection to insure compliance of the equipment with these specifications.
- 1.2 These test procedures shall be followed by the Contractor who shall certify that he has conducted inspection and testing in accordance with these specifications.

#### 2. Inspection

A visual and physical inspection shall include mechanical, dimensional and assembly conformance of all parts of these specifications which can be checked visually or manually with simple measuring devices. Workmanship shall be in accordance with the highest industry standards.

#### 3. Environmental

All components shall properly operate within the following limits:

- 3.1 Ambient Temperature:  $-37^{\circ}\text{C}$  to  $+74^{\circ}\text{C}$
- 3.2 Humidity: 5 percent to 95 percent
- 3.3 The relative humidity and ambient temperature values in the following table shall not be exceeded.

AMBIENT TEMPERATURE VERSUS RELATIVE  
HUMIDITY AT BAROMETRIC PRESSURES (29.92 In. Hg.)

Ambient Temperature/ Dry Bulb (in $^{\circ}\text{C}$ )	Relative Humidity (in percent)	Ambient Temperature/ Wet Bulb (in $^{\circ}\text{C}$ )
$-37^{\circ}$ to 1.1	10	$-17.2$ to 42.7
1.1 to 46.0	95	42.7
48.8	70	42.7
54.4	50	42.7
60.0	38	42.7
65.4	28	42.7
71.2	21	42.7
74	18	42.7

3.4 Shock Test: per Military Specification:  
MIL-STD-810 Method 516.1

3.5 Vibration per Military Specification:  
MIL-STD-810 Method 514.1,  
equipment class G (Common  
Carrier)

3.7 The Cabinet shall comply with the requirements of  
UL Bulletin of Research No. 23, "Rain Tests of  
Electrical Equipment".

3.8 All equipment shall continue normal operation  
when subjected to the following:

3.8.1 Low Temperature Test

With the item functioning at a line voltage  
of 95 VAC in its intended operation, the  
ambient temperature shall be lowered from  
20° C to -37° C at a rate of not more than  
18° C per hour. The item shall be cycled  
at -37° C for a period of 5 hours and then  
returned to 20° C at the same rate. The  
test shall be repeated with the line voltage  
at 135 VAC.

3.8.2 High Temperature Test

With the item functioning at a line voltage  
of 95 VAC in its intended operation, the  
ambient temperature shall be raised from  
20° C to 70° C at a rate of not more than  
18° C per hour. The item shall be cycled  
at 70° C for 5 hours and then returned to  
20° C at the same rate. The test shall be  
repeated with the line voltage at 135 VAC.

4. Electrical

All components shall operate properly within the following  
limits.

4.1 Applied Line Voltage: 115± 20 Volts AC

4.2 Frequency: 60± 3.0 Hertz

4.3 All circuits shall commence operation at or below 95  
Volts as the applied voltage is raised from 50 Volts  
to 95 Volts at a rate not to exceed 3 Volts per Second.

- 4.4 All cabinets and the equipment to be housed within the cabinet shall be unaffected by transient voltages normally experienced on commercial power lines.
- 4.4.1 The protection shall enable the unit being tested to withstand the discharge of a 25 microfarad capacitor charged to plus and minus ( $\pm$ ) 2,000 volts applied directly across the AC line at a rate of once every ten (10) seconds for a maximum of 50 occurrences per test. The unit under test will be operated at room temperature and at 120 volts.
- 4.5 All equipment to be housed in the cabinet shall be unaffected by the following powerline transient voltages applied at the cabinet service terminal with the cabinet power surge protectors removed.
- 4.5.1 This protection shall enable the unit or equipment being tested to withstand the discharge of one plus or minus 300 volt pulse synchronously added to the AC line and moved uniformly over the full wave across 360° of line cycle once every three seconds. Peak noise power shall be 5 kilowatts with a pulse rise time of 500 nanoseconds. The unit under test will be operated at room temperature and at 120 volts AC.
- 4.6 All equipment shall be capable of normal operation following opening and closing of contacts in series with the applied voltage to the cabinet at a rate of 30 openings and closings per minute for a period of 2 minutes in duration.
- 4.7 All equipment shall resume normal operation following a period of at least five (5) hours at -37° C and less than 10 percent humidity, when 95 volts AC is applied to the input terminals of the cabinet.

## 5. Test Program

- 5.1 A test program shall be provided by the Contractor of the controller unit. The program shall be written in the specified MPU Language and shall be resident in all delivered controller units. The program shall test the following operations:
1. All inputs, outputs, specified control functions, communication functions, and indications in the unit.

2. Read-Write function for all Memory Chips and Sockets, except read-only test for PROM.

The program shall run continuously, testing and recording failures. The program shall stop only if the Stop Time Switch is "ON". At the time the switch is placed in the "ON" position, the test currently running shall continue to completion. At completion, the test status as to pass, fail and type of failure shall be displayed.

A test shall be provided at the end of the program that sums the number of completed test cycles, test failures, and number of said failures.

- 5.2 Ten manuals containing the flow chart, listing, and instructions of the test program shall be furnished when the first controller unit is delivered for testing.

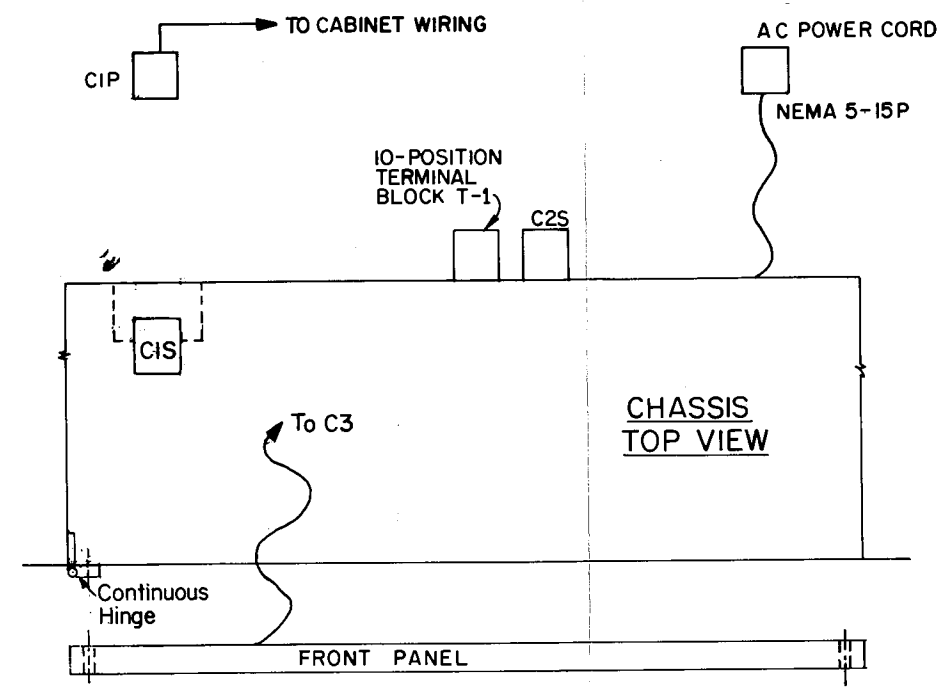
## 6. Contractor's Testing Certification

- 6.1 The Contractor shall supply with each item a State approved full test report of the quality control and final test conducted on each item. The test report shall indicate the name of the tester and shall be signed by a responsible manager.
- 6.2 The Contractor shall submit his quality control procedure for approval by the State Testing Laboratory within 15 days following the approval of the contract.
- 6.3 The quality control procedure shall include the following:
  - 6.3.1 Acceptance testing of all supplied components.
  - 6.3.2 Physical and functional testing of all modules.
  - 6.3.3 A minimum 100-hour burn-in of all modules.
  - 6.3.4 Physical and functional testing of all items.
  - 6.3.5 A minimum 24 hour operation of all controller units.
  - 6.3.6 A separate test area to be set aside by the Contractor where the State inspector will have free access to witness quality control inspection and testing being performed.

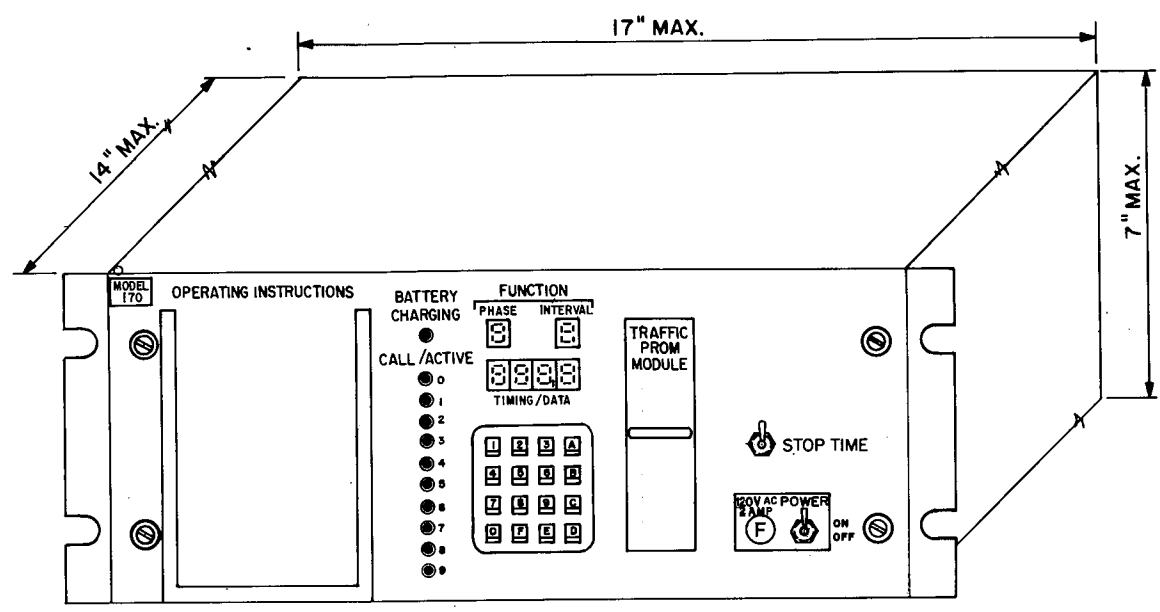
## SECTION IX

### PLANS

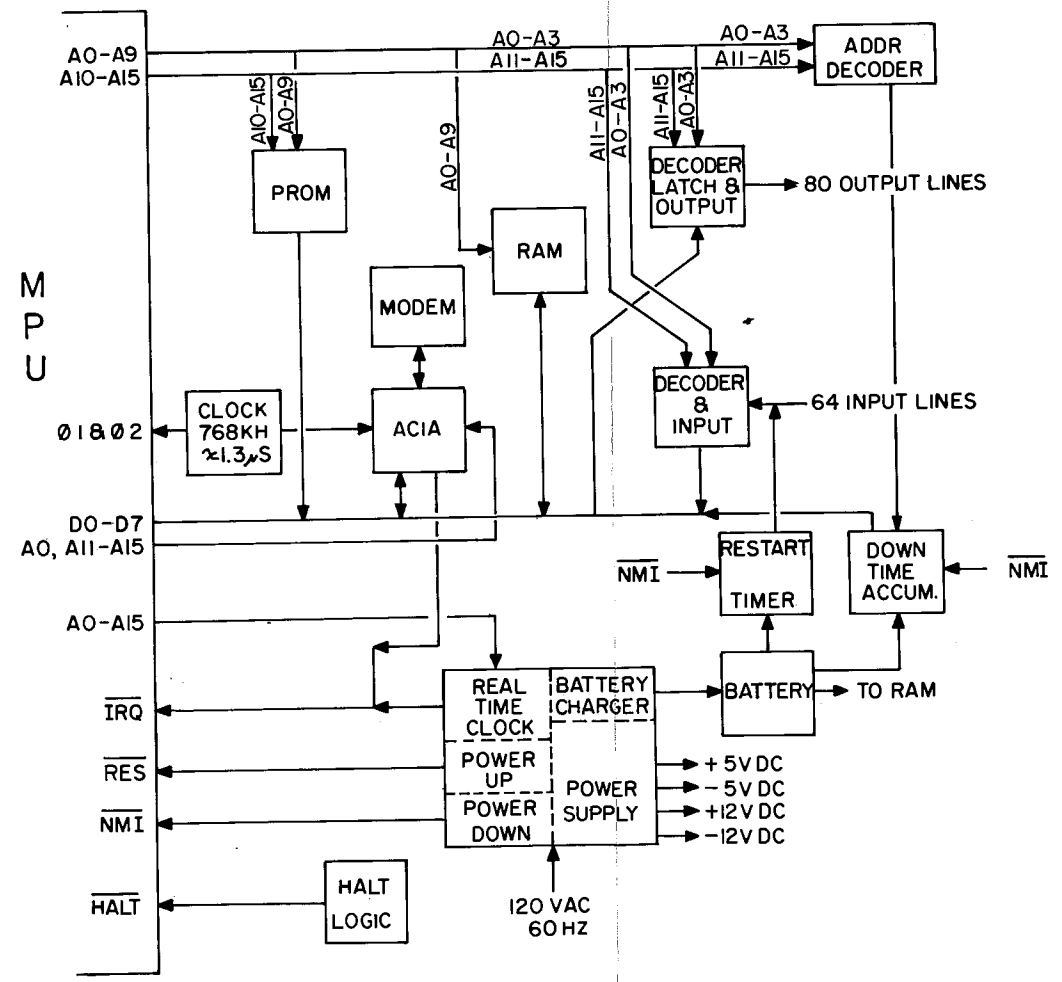
1. Plans referred to in these specifications shall incorporate the following sheets.



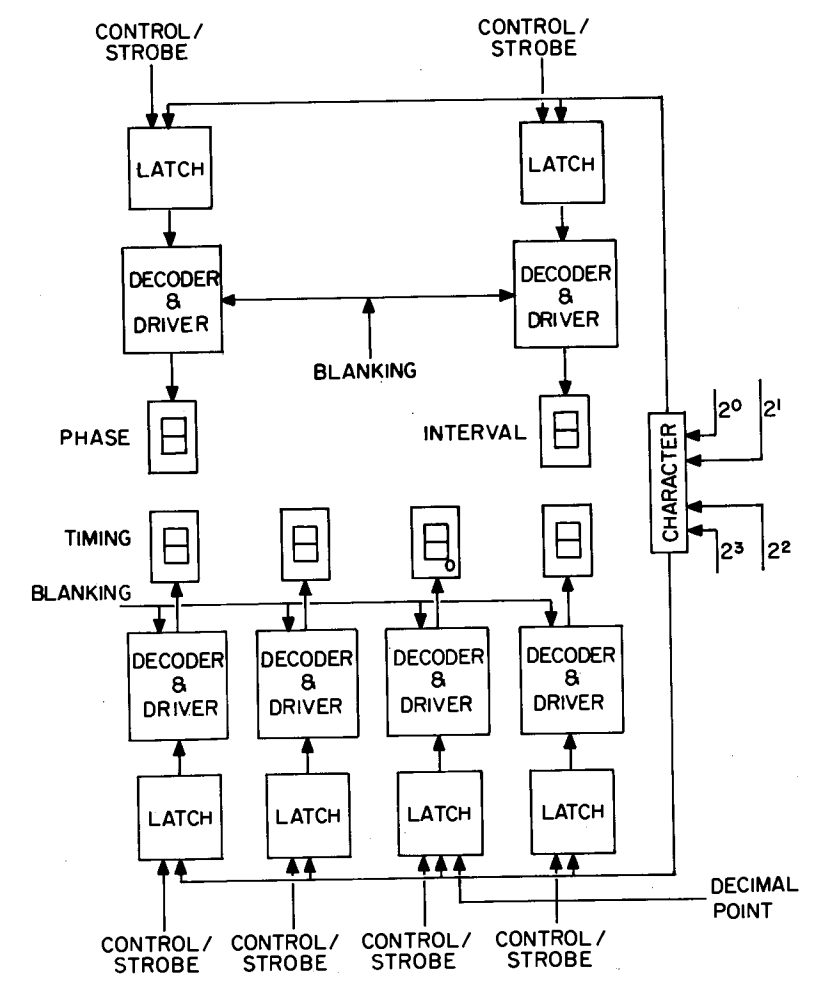
TOP VIEW



FRONT PANEL DISPLAY



ORGANIZATION OF MODEL 170 CONTROLLER UNIT BLOCK DIAGRAM

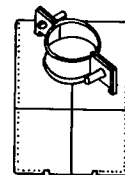
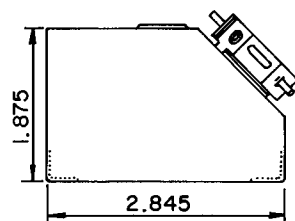


FRONT PANEL DISPLAY BLOCK DIAGRAM

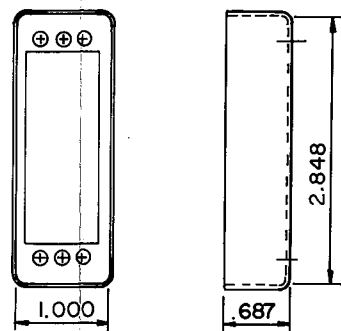
### MODEL 170 CONTROLLER UNIT NOTES

- The terminal block T1 shall be barrier type with 6-32 or longer nickel plated brass binder head screws. Terminals shall be permanently identified as to their function.
- All logic connections into or out of the controller unit shall be made through IO4- socket connector C1. The connector block shall have an insulation resistance of 5000 megohms. Contacts shall be secured in the blocks with stainless steel springs.
  - Contacts shall be beryllium copper construction, subplated with 0.00005-inch nickel and plated with 0.00003-inch gold. Sockets shall accept pin contacts 0.062-inch in diameter. The connector shall contain the socket contacts.
  - Corner guide pin assemblies for pin connectors shall be stainless steel and shall be 1.097 inches in length. Corner guide socket assemblies shall be stainless steel and shall be 0.625 inch in length.
  - Connector C1S shall be recessed and mounted on the right rear panel of the chassis.

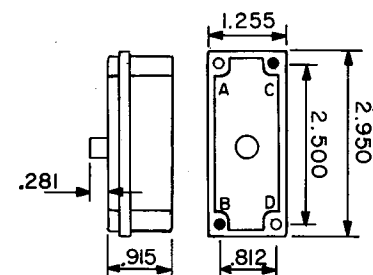
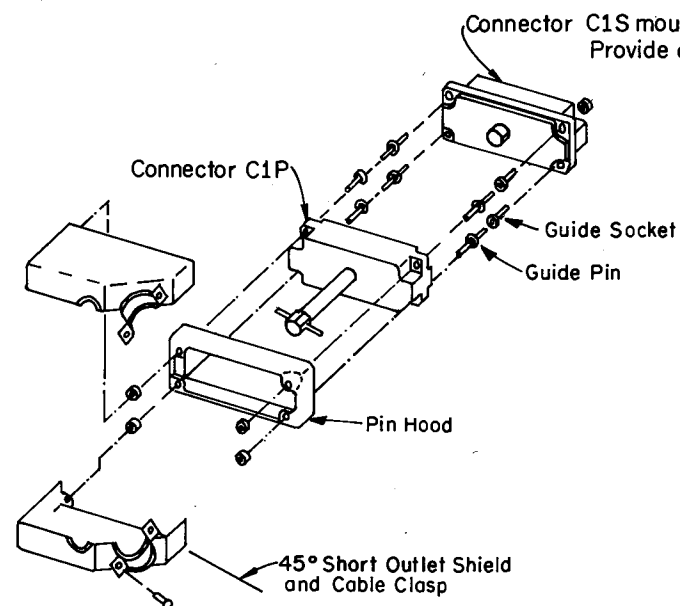




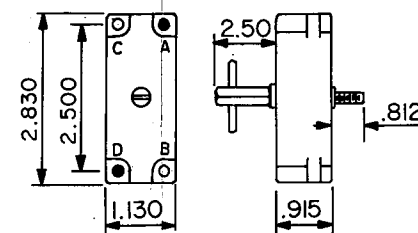
SHIELD FOR C1P



HOOD FOR C1P



CORNER GUIDES  
pins B and C  
sockets A and D  
CONNECTOR C1S



CORNER GUIDES  
pins A and D  
sockets B and C  
CONNECTOR C1P

DISTRICT	COUNTY	ROUTE	P-1st Miles - Total	Project	SHEET NO.	TOTAL SHEETS

CONNECTOR C1 AND CONNECTOR C3 CONTACT  
ASSIGNMENTS AND OUTPUT PORT ADDRESS ASSIGNMENTS

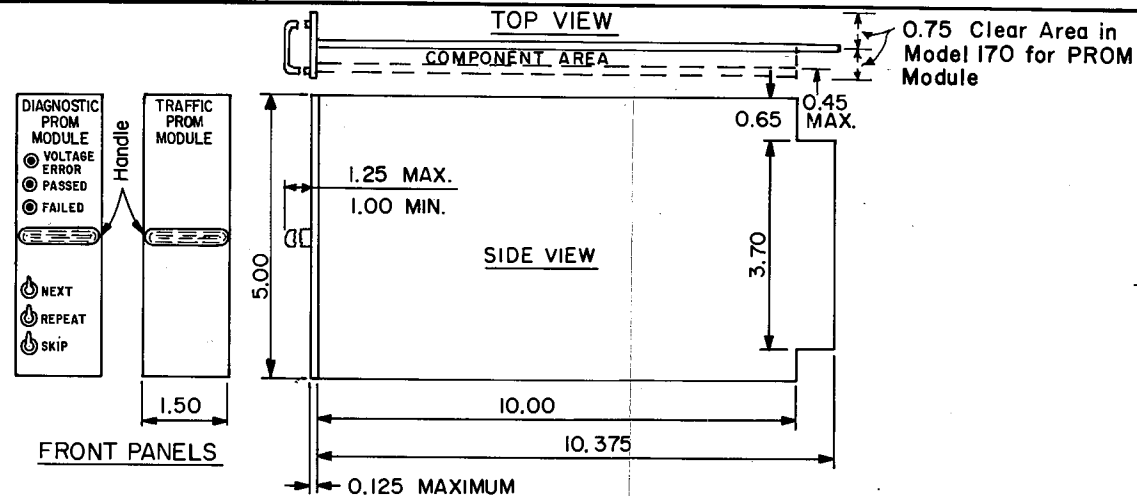
OUTPUT PORT ADDRESS	BIT	CONNECTOR C1 SOCKET CONTACTS	CONNECTOR C3	OUTPUT PORT ADDRESS	BIT	CONNECTOR C1 SOCKET CONTACTS	CONNECTOR C3
5001	1	2		5006	1	83	
5001	2	3		5006	2	84	
5001	3	4		5006	3	85	
5001	4	5		5006	4	86	
5001	5	6		5006	5	87	
5001	6	7		5006	6	88	
5001	7	8		5006	7	89	
5001	8	9		5006	8	90	
5002	1	10		5007	1	91	
5002	2	11		5007	2	93	
5002	3	12		5007	3	94	
5002	4	13		5007	4	95	
5002	5	15		5007	5	96	NC
5002	6	16		5007	6	97	NC
5002	7	17		5007	7	98	NC
5002	8	18		5007	8	99	NC
5003	1	19		5008	1		CC-PHASE
5003	2	20		5008	2		CC-INTERVAL
5003	3	21		5008	3		CC-TIMING LS
5003	4	22		5008	4		CC-TIMING NLS
5003	5	23		5008	5		CC-TIMING NMS
5003	6	24		5008	6		CC-TIMING MS
5003	7	25		5008	7		CALL LT 8
5003	8	26		5008	8		CALL LT 9
5004	1	27		5009	1		CH-LS
5004	2	28		5009	2		CH-NLS
5004	3	29		5009	3		CH-NMS
5004	4	30		5009	4		CH-MS
5004	5	31		5009	5		DP
5004	6	32		5009	6		BL-P&L
5004	7	33		5009	7		BL-TIMING
5004	8	34		5009	8		NC
5005	1	35		500A	1		CALL LT 0
5005	2	36		500A	2		CALL LT 1
5005	3	37		500A	3		CALL LT 2
5005	4	38		500A	4		CALL LT 3
5005	5	100		500A	5		CALL LT 4
5005	6	101		500A	6		CALL LT 5
5005	7	102		500A	7		CALL LT 6
5005	8	103		500A	8		CALL LT 7

CONNECTOR C1 AND CONNECTOR C3 CONTACT  
ASSIGNMENTS AND INPUT PORT ADDRESS ASSIGNMENTS

INPUT PORT ADDRESS	BIT	CONNECTOR C1 SOCKET CONTACTS	CONNECTOR C3	INPUT PORT ADDRESS	BIT	CONNECTOR C1 SOCKET CONTACTS	CONNECTOR C3
5001	1	39		5005	1	67	
5001	2	40		5005	2	68	
5001	3	41		5005	3	69	
5001	4	42		5005	4	70	
5001	5	43		5005	5	71	
5001	6	44		5005	6	72	
5001	7	45		5005	7	73	
5001	8	46		5005	8	74	
5002	1	47		5006	1	75	
5002	2	48		5006	2	76	
5002	3	49		5006	3	77	
5002	4	50		5006	4	78	
5002	5	51		5006	5	79	
5002	6	52		5006	6	80	
5002	7	53		5006	7	81	
5002	8	54		5006	8	82	
5003	1	55		5007	1		KEYBOARD CONTROL
5003	2	56		5007	2		KEYBOARD CH LS
5003	3	57		5007	3		KEYBOARD CH NLS
5003	4	58		5007	4		KEYBOARD CH NMS
5003	5	59		5007	5		KEYBOARD CH MS
5003	6	60		5007	6		STOP TIMING
5003	7	61		5007	7		NC
5003	8	62		5007	8		NC
5004	1	* 1		5008	1		NC
5004	2	* 2		5008	2		NC
5004	3	* 3		5008	3		NC
5004	4	* 4		5008	4		NC
5004	5	63		5008	5		NC
5004	6	64		5008	6		NC
5004	7	65		5008	7	* 5	
5004	8	66		5008	8	* 6	

- DEFINITIONS
- CC = CHARACTER CONTROL OR BLANKING.  
CH = CHARACTER  
BL = BLANKING  
NC = TERMINATED AT CONNECTOR FOR FUTURE USE.  
LS = LEAST SIGNIFICANT.  
NLS = NEXT LEAST SIGNIFICANT.  
NMS = NEXT MOST SIGNIFICANT  
MS = MOST SIGNIFICANT.  
DP = DECIMAL POINT.  
P&I = PHASE AND INTERVAL.  
\* = ALSO GOES TO THE "PROM" MODULE MATING CONNECTOR PIN # 51, "TEST COMPLETE".  
\* 1 = GOES TO THE OUTPUT OF THE RESTART TIMER.  
\* 2 = GOES TO THE "PROM" MODULE MATING CONNECTOR PIN # 50, "NEXT TEST."  
\* 3 = GOES TO THE "PROM" MODULE MATING CONNECTOR PIN # 49, "REPEAT TEST."  
\* 4 = GOES TO THE "PROM" MODULE MATING CONNECTOR PIN # 52, "SKIP TEST."  
\* 5 = GOES TO THE "PROM" MODULE MATING CONNECTOR PIN # 55, SPARE.  
\* 6 = GOES TO THE "PROM" MODULE MATING CONNECTOR PIN # 54, SPARE.

- NOTES
1. All dimensions shown are in inches.  
2. C1 Connector Pins 1, 14, 92 and 104 shall be connected to the Controller Unit DC Logic Ground.



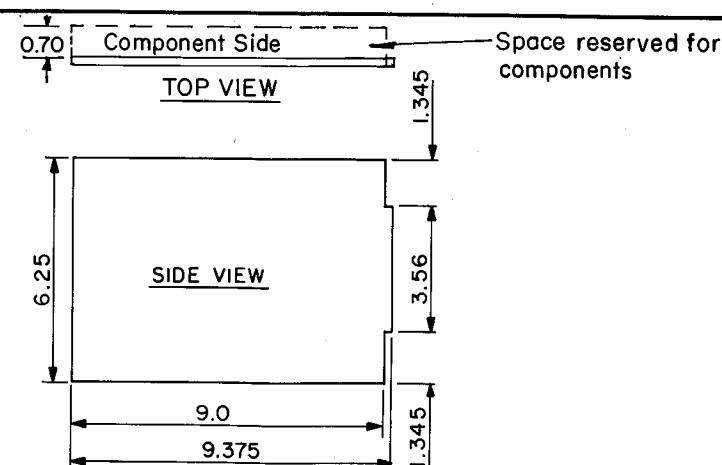
### PROM MODULES

Traffic Prom Module and  
MODEL 410 Diagnostic  
Prom Module

### CIRCUIT ASSIGNMENTS FOR PROM MODULE CONNECTOR

CIRCUIT SIDE		COMPONENT SIDE	
A0	1	2	A1
A2	3	4	A3
A4	5	6	A5
A6	7	8	A7
A8	9	10	A9
A10	11	12	A11
A12	13	14	A13
A14	15	16	A15
D0	17	18	D1
D2	19	20	D3
D4	21	22	D5
D6	23	24	D7
VMA *	25	26	Unassigned
Read/Write	27	28	Unassigned
Unassigned	29	30	Unassigned
Unassigned	31	32	Unassigned
Unassigned	33	34	Equipment Ground
Unassigned	35	36	Unassigned
Unassigned	37	38	Unassigned
Unassigned	39	40	Unassigned
Unassigned	41	42	Unassigned
Unassigned	43	44	Unassigned
Unassigned	45	46	Unassigned
Unassigned	47	48	Unassigned
Repeat Test	49	50	Next Test
Test Complete	51	52	Skip Test
Unassigned	53	54	Unassigned
Unassigned	55	56	Unassigned
Unassigned	57	58	Unassigned
+12 VDC	59	60	+12 VDC
-12 VDC	61	62	-12 VDC
-5 VDC	63	64	-5 VDC
+5 VDC	65	66	+5 VDC
+5 VDC	67	68	+5 VDC
GND	69	70	GND
GND	71	72	GND

\* Includes Phase 2 Clock, Logic external  
to PROM MODULE.



### MODEL 400 MODEM MODULE

### CIRCUIT ASSIGNMENTS FOR MODEM MODULE CONNECTOR

COMPONENT SIDE		CIRCUIT SIDE	
PIN	FUNCTION	PIN	FUNCTION
1	NC	A	DC Ground
2	Audio Input	B	DC Ground
3	Audio Input	C	+12 VDC
4	NC	D	+12 VDC
5	NC	E	-12 VDC
6	NC	F	-12 VDC
7	NC	H	NC
8	NC	J	NC
9	NC	K	Carrier Detect(CD)
10	NC	L	Request to Send(RTS)
11	NC	M	Data Input
12	NC	N	Clear to Send(CTS)
13	NC	P	Data Output
14	NC	R	NC
15	NC	S	NC
16	NC	T	NC
17	NC	U	NC
18	NC	V	NC
19	NC	W	NC
20	NC	X	* Audio Output
21	NC	Y	* Audio Output
22	NC	Z	NC

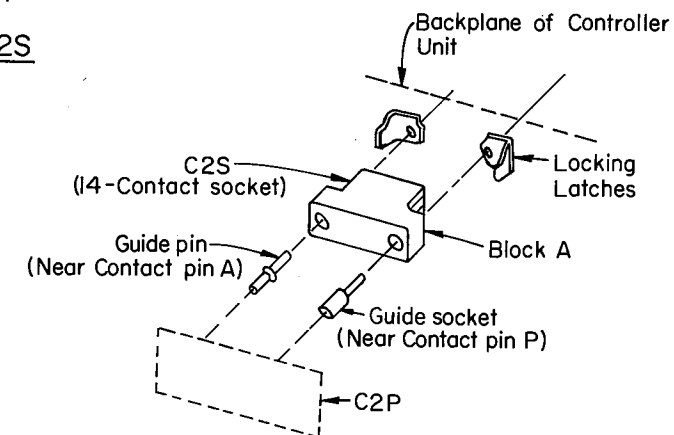
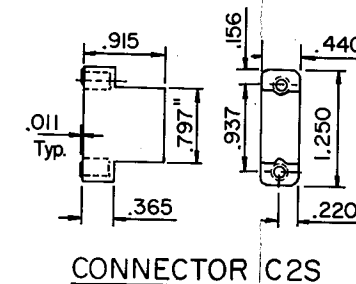
— Keyed

\* Switch selectable two wire or four wire operation.  
In two wire operation x and y shall be used for Audio I/O.

### SYSTEM ADDRESSING

FUNCTION	ADDRESS RANGE	# OF BYTES	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
PROM	E000-FFFF	8K	1	1	1	V	V	V	V	V	V	V	V	V	V	V	V	V
RESERVED	0400-4FFF 7000-DFFF	47K	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
RAM	0000-03FF	1K	0	0	0	0	0	0	V	V	V	V	V	V	V	V	V	V
DTA(Minutes)	5000	1	0	1	0	1	0	-	-	-	-	-	-	-	0	0	0	0
DTA(Seconds)	500F	1	0	1	0	1	0	-	-	-	-	-	-	-	1	1	1	1
Input/Output	5001-500A	10	0	1	0	1	0	-	-	-	-	-	-	-	V	V	V	V
Real Time Clock reset	5FFF	1	0	1	0	1	1	-	-	-	-	-	-	-	1	1	1	1
ACIA (RDR & TDR)	6001	1	0	1	1	0	0	-	-	-	-	-	-	-	-	-	-	1
ACIA (SR & CR)	6000	1	0	1	1	0	0	-	-	-	-	-	-	-	-	-	-	0

V = Variable  
0 = Ground  
1 = +5 VDC  
- = Dont Care



NOTE: Connector C2P to be furnished only when  
required by Contract.

### CONNECTOR C2

### CONNECTOR C2 SOCKET ASSIGNMENT

<u>C2</u>			<u>C2</u>		
<u>Socket</u>	<u>Contacts</u>	<u>Function</u>	<u>Socket</u>	<u>Contacts</u>	<u>Function</u>
	A	Audio IN		J	RTS
	B	Audio IN		K	Data IN
	C	Audio OUT		L	Data Out
	D	+5VDC		M	CTS
	E	Audio OUT		N	DC GND.
	F	-5VDC		P	
	H	CD		R	

### TERMINAL BLOCK T1 ASSIGNMENT

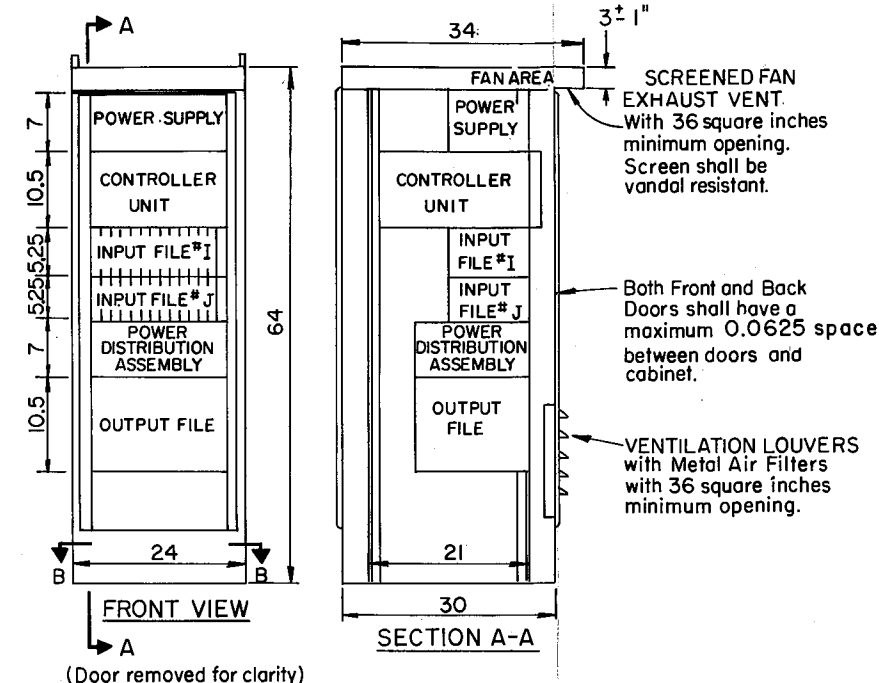
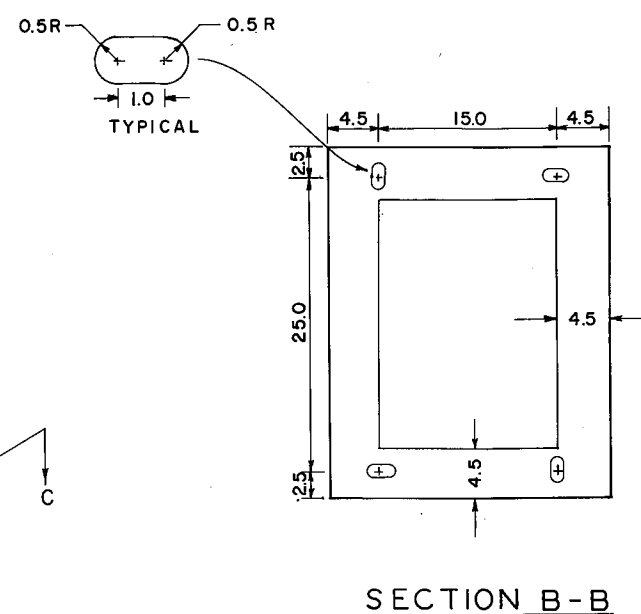
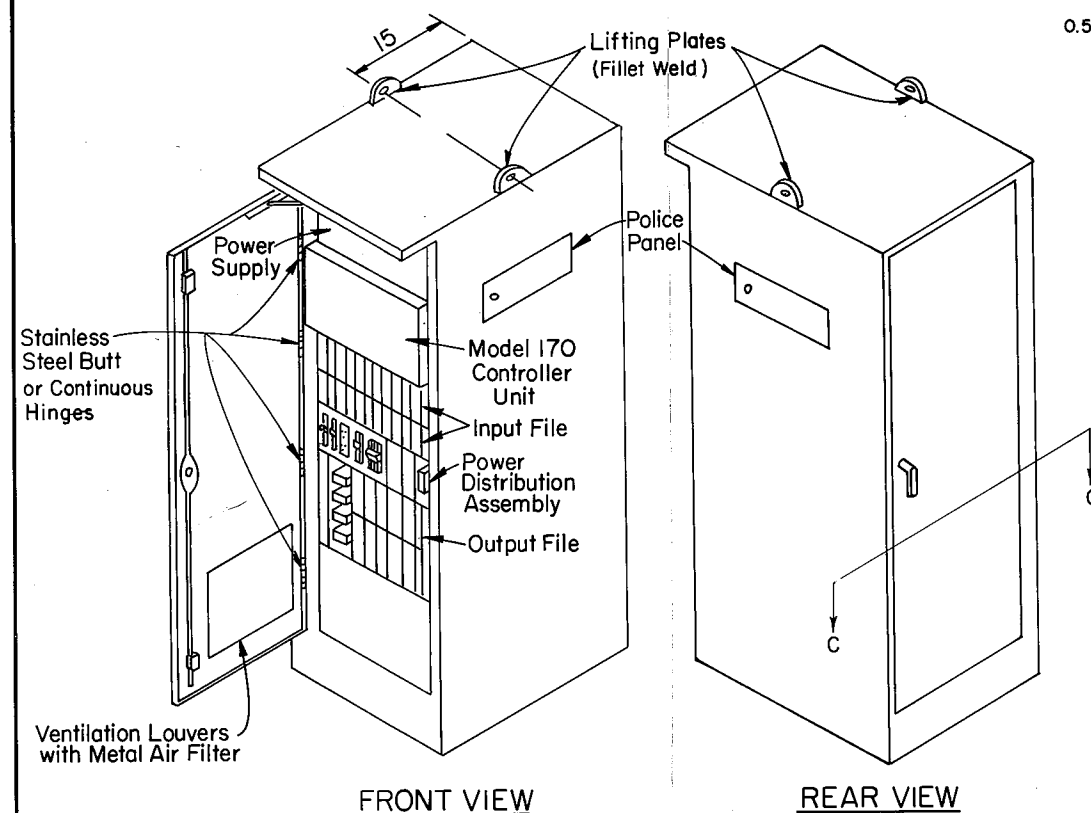
1. Audio IN	6. CTS
2. Audio IN	7. Data Out
3. CD	8. Audio Out
4. RTS	9. Audio Out
5. Data IN	10. DC GND.

NOTES (This Sheet)

1. All dimensions shown are in inches

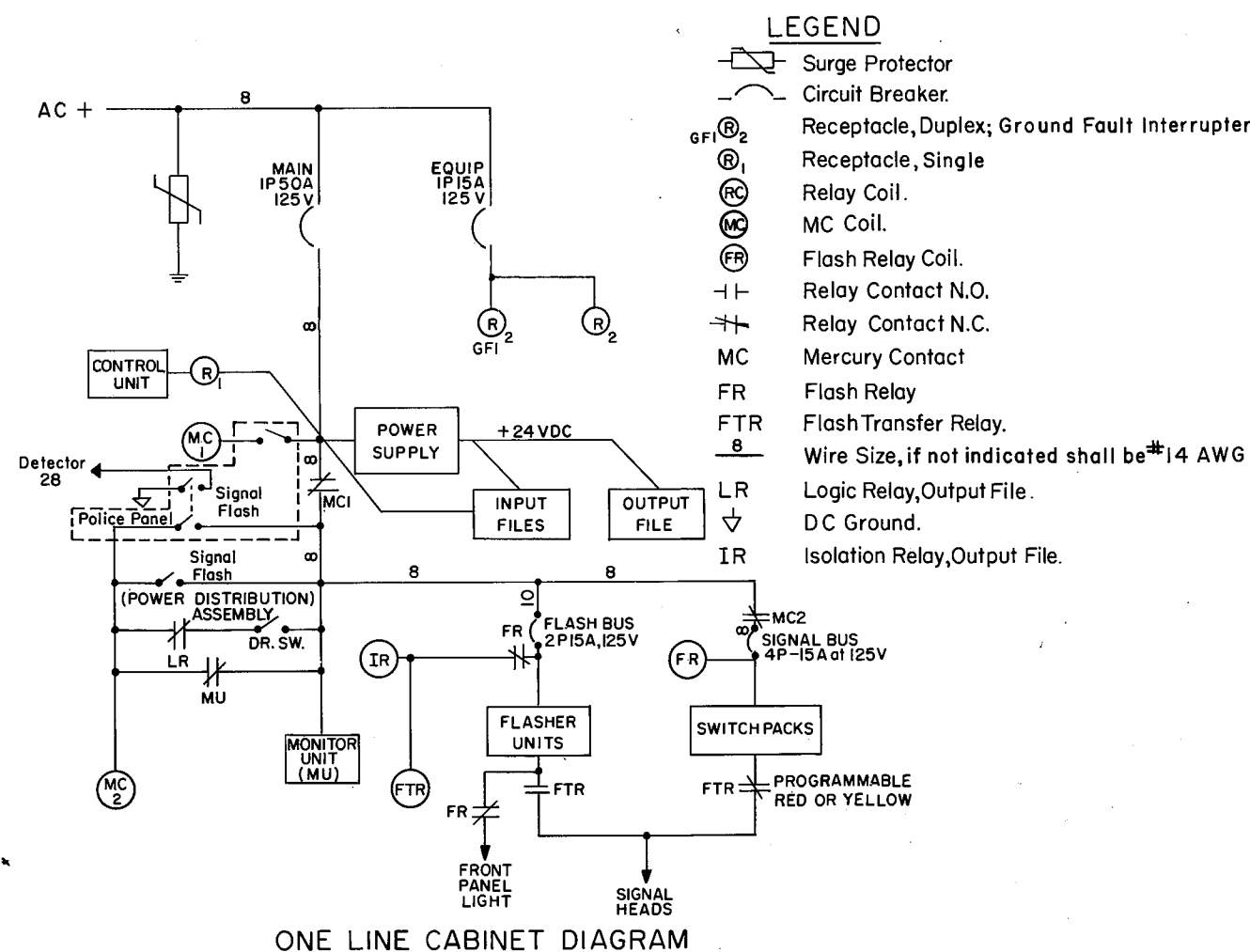
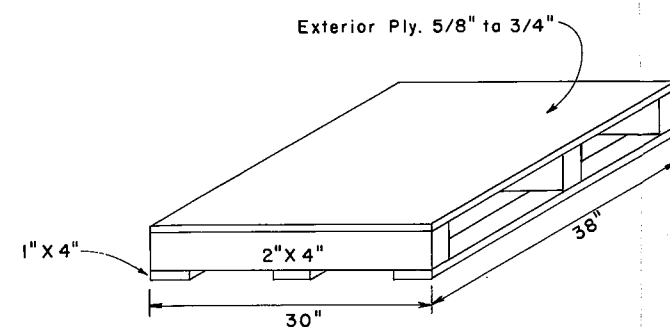
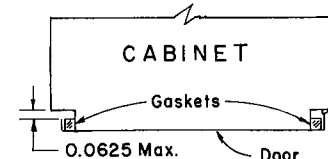
MODEL 170  
CONTROLLER UNIT

170-3



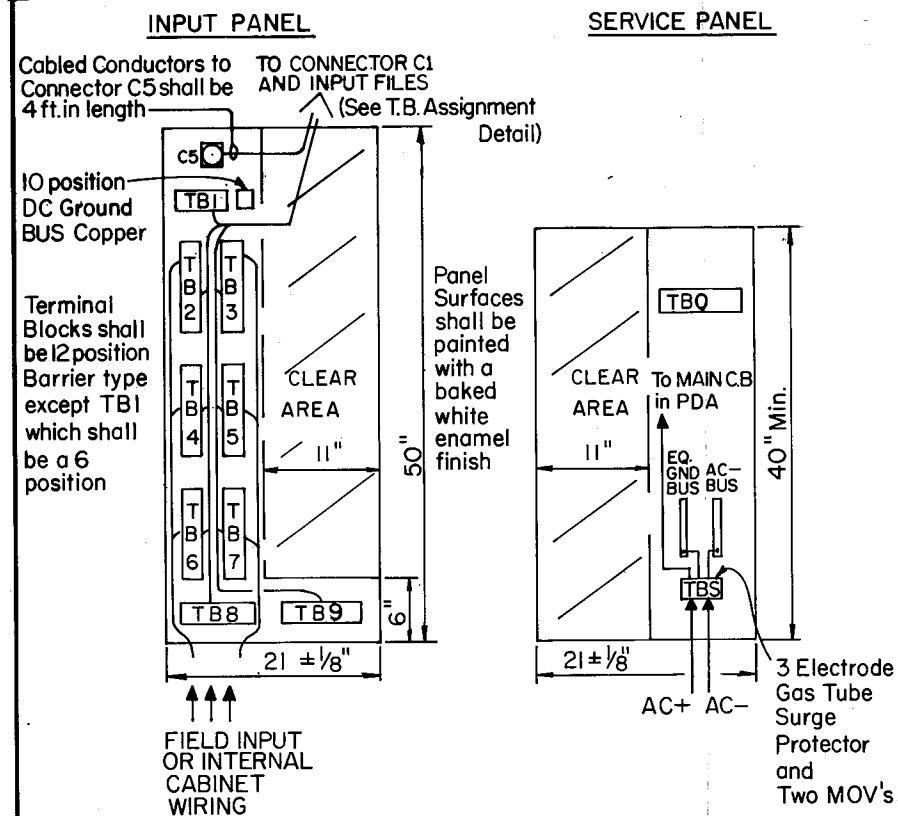
**CABINET DETAILS**

**SECTION C-C**  
TYPICAL



- LEGEND**
- Surge Protector
  - Circuit Breaker
  - Receptacle, Duplex; Ground Fault Interrupter.
  - Receptacle, Single
  - Relay Coil.
  - MC Coil.
  - Flash Relay Coil.
  - Relay Contact N.O.
  - Relay Contact N.C.
  - Mercury Contact
  - Flash Relay
  - Flash Transfer Relay.
  - Wire Size, if not indicated shall be #14 AWG
  - Logic Relay, Output File.
  - DC Ground.
  - Isolation Relay, Output File.

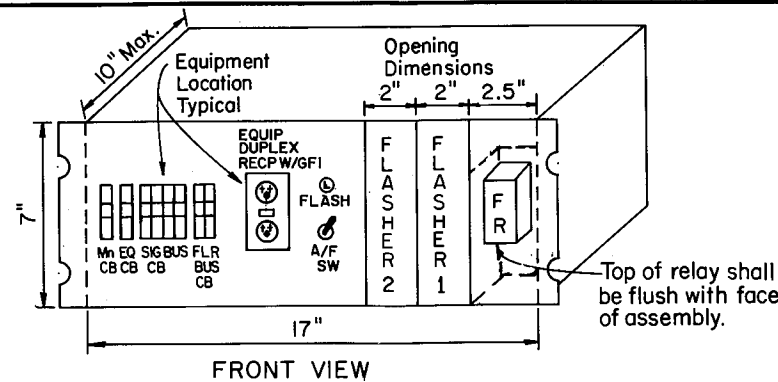
**NOTES (This Sheet)**  
1. All dimensions shown are in inches and tolerances shall be  $\pm 0.125$ .



**SIDE PANEL DETAIL**

POS	A	B	POS	A	B	POS	A	B
TB1-1	+24VDC	OF, IF1, IFJ, M	TB4-1	Det 7	I-4D	TB7-1	Det 33	J-7D
2	M Reset	NA	2	Det 7	I-4E	2	Det 33	J-7E
3	NA	NA	3	Det 8	I-4J	3	Det 34	J-7J
4	NA	NA	4	Det 8	I-4K	4	Det 34	J-7K
5	NA	NA	5	Det 9	I-5D	5	Det 35	J-8D
6	NA	NA	6	Det 9	I-5E	6	Det 35	J-8E
			7	Det 10	I-5J	7	Det 36	J-8J
			8	Det 10	I-5K	8	Det 36	J-8K
			9	Det 11	I-6D	9	Det 37	J-9D
			10	Det 11	I-6E	10	Det 37	J-9E
			11	Det 12	I-6J	11	Det 38	J-9J
			12	Det 12	I-6K	12	Det 38	J-9K
TB2-1	Det 1	I-1D	TB5-1	Det 25	J-4D	TB8-1	MANUAL I-11D	
2	Det 1	I-1E	2	Det 25	J-4E	2	SPARE I-11J	
3	Det 2	I-1J	3	Det 26	J-4J	3	11 COM I-11K	
4	Det 2	I-1K	4	Det 26	J-4K	4	PED Ø2 I-12D	
5	Det 3	I-2D	5	Det 29	J-5D	5	PED Ø4 I-12J	
6	Det 3	I-2E	6	Det 29	J-5E	6	12 COM I-12K	
7	Det 4	I-2J	7	Det 30	J-5J	7	PED Ø6 I-13D	
8	Det 4	I-2K	8	Det 30	J-5K	8	PED Ø8 I-13J	
9	Det 5	I-3D	9	Det 31	J-6D	9	13 COM I-13K	
10	Det 5	I-3E	10	Det 31	J-6E	10	FLH SENSE I-14D	
11	Det 6	I-3J	11	Det 32	J-6J	11	STOP TIME I-14J	
12	Det 6	I-3K	12	Det 32	J-6K	12	14 COM I-14K	
TB3-1	Det 19	J-1D	TB6-1	Det 13	I-7D	TB9-1	SPARE 2J-11D	
2	Det 19	J-1E	2	Det 13	I-7E	2	SPARE 3J-11J	
3	Det 20	J-1J	3	Det 14	I-7J	3	11 COM J-11K	
4	Det 20	J-1K	4	Det 14	I-7K	4	EM 25 J-12D	
5	Det 21	J-2D	5	Det 15	I-8D	5	EM 61 J-12J	
6	Det 21	J-2E	6	Det 15	I-8E	6	12 COM J-12K	
7	Det 22	J-2J	7	Det 16	I-8J	7	EM 47 J-13D	
8	Det 22	J-2K	8	Det 16	I-8K	8	EM 81 J-13J	
9	Det 23	J-3D	9	Det 17	I-9D	9	13 COM J-13K	
10	Det 23	J-3E	10	Det 17	I-9E	10	RR 25 J-14D	
11	Det 24	J-3J	11	Det 18	I-9J	11	RR 47 J-14J	
12	Det 24	J-3K	12	Det 18	I-9K	12	14 COM J-14K	

**PANEL TERMINAL BLOCK ASSIGNMENT DETAIL**

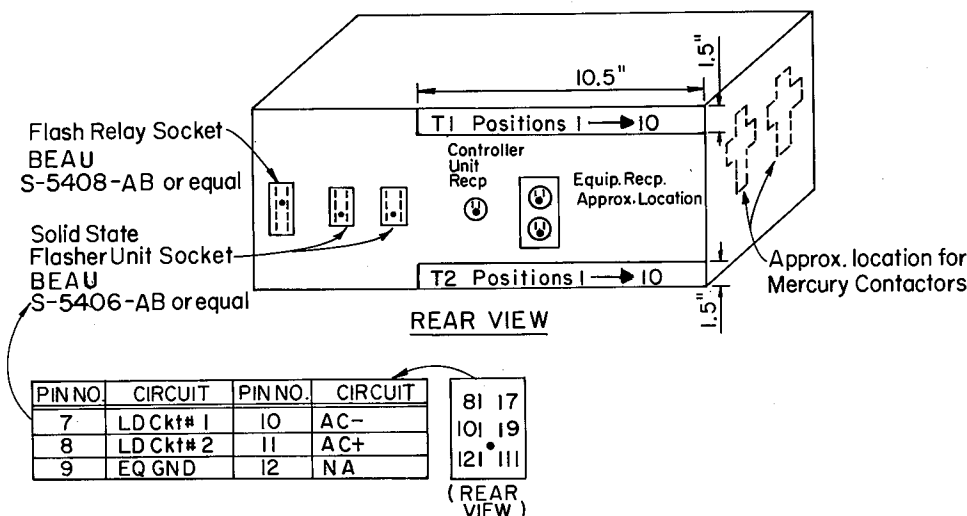
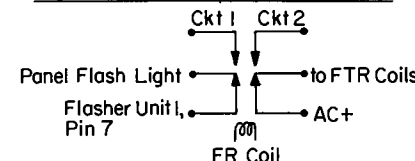


**CONNECTOR SOCKET FLASH RELAY**

PIN NO.	CIRCUIT	PIN NO.	CIRCUIT
1	Coil	5	COM Ckt# 1
2	Coil	6	COM Ckt# 2
3	NC Ckt# 1	7	NO Ckt# 1
4	NC Ckt# 2	8	NO Ckt# 2

Contacts shall be rated 15 Amperes Minimum.

**FLASH RELAY WIRING DIAGRAM**



**POWER DISTRIBUTION ASSEMBLY DETAIL**

**LEGEND**

NA - Not Assigned.

OF - Output File.

IF1 - Input File # 1.

IFJ - Input File # J.

M - Monitor Module.

I-1D - IF1 Slot 1 Connector, Pin D.

RR25 - Railroad Preempt, Ø 2 and Ø 5

EM25 - Emergency Vehicle Ø 2 and Ø 5

O11 - Output File Terminal Block, Position 11.

**POWER DISTRIBUTION ASSEMBLY T1 AND T2  
TERMINAL BLOCK ASSIGNMENT DETAIL**

T1 and T2 shall be 10 Position Barrier Type.

T1			T2		
POSITION	A(INT)	B(EXT)	POSITION	A(EXT)	B(INT)
1.	EQ GND	EQ GND BUS	1.	Spare	Spare
2.	{ AC-Recp AC-Coils & Misc. AC-F/H Units Main CB(Secondary) }	AC- Bus	2.	05	FLH Unit 1, Pin 7
3.			3.	06	FLH Unit 1, Pin 8
4.			4.	07	FLH Unit 2, Pin 7
5.			5.	08	FLH Unit 2, Pin 8
6.		Fan, P.S., Police Panel On-Off Sw, Input Files O12, Police Panel A/Fsw Police Panel On-Off Sw O11, LR Door Sw	6.	014	Power to FTR Coils
7.	MC 2 Coil		7.	01	SIG CB, CKT 1
8.	MC 1 Coil		8.	02	SIG CB, CKT 2
9.	MC 1 (Secondary)		9.	03	SIG CB, CKT 3
10.	Spare	Spare	10.	04	SIG CB, CKT 4

DC Ground

24VDC

Loop Key

Reset

Loop No.1 Magnetometer No.1

Loop No.1 Magnetometer No.1

Loop No.1 Magnetometer No.1 (collector)

Loop No.1 Magnetometer No.1 (emitter)

Magnetometer No.1 excitation

Loop No.2 Magnetometer No.1 excitation

Loop No.2 Chassis Ground

AC-

Loop Key

AC+

Loop No.3 Magnetometer No.2

Loop No.3 Magnetometer No.2

Loop No.3 Magnetometer No.2 Output (collector)

Loop No.3 Magnetometer No.2 Output (emitter)

Magnetometer No.2 excitation

Loop No.4 Magnetometer No.2 excitation

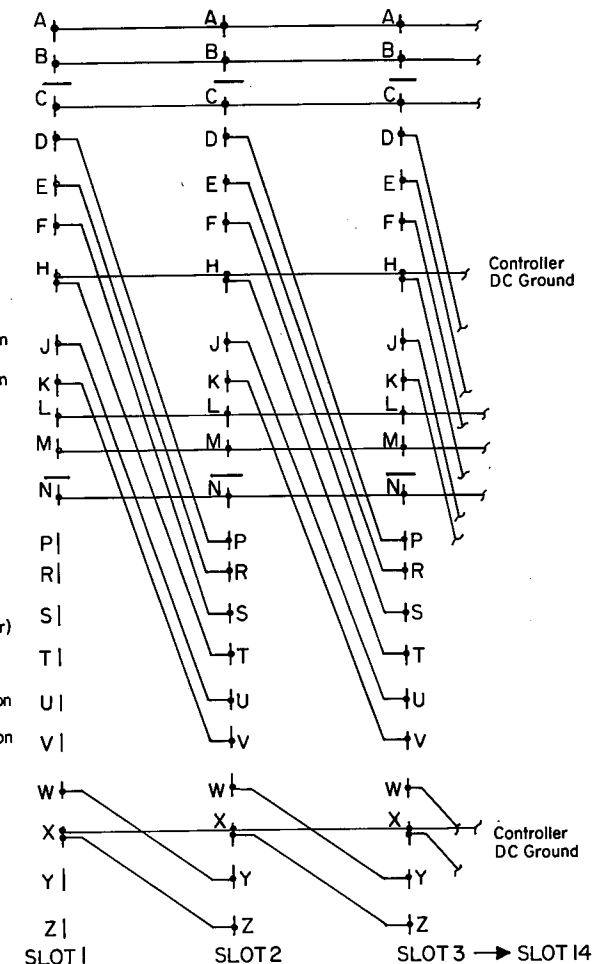
Loop No.4

Loop No.2 Output (collector)

Loop No.2 Output (emitter)

Loop No.4 (collector)

Loop No.4 (emitter)



## CONNECTOR - C1 WIRING LIST

PIN	SOURCE	DEST.	FUNCTION	PIN	SOURCE	DEST.	FUNCTION
1	DCGROUND	DC GND BUS		53	I2-7	IFI-11L	INPUT 15
2	01-1 C4-1	SWPK 4P-RED		54	I2-8	IFJ-11U	INPUT 16
3	01-2 C4-2	SWPK 4P-GRN		55	I3-1	IFJ-1U8L	INPUT 17
4	01-3 C4-3	SWPK 4P-RED		56	I3-2	IFI-1U8L	INPUT 18
5	01-4 C4-4	SWPK 4P-YEL		57	I3-3	IFJ-5U8L	INPUT 19
6	01-5 C4-5	SWPK 4P-GRN		58	I3-4	IFI-5U8L	INPUT 20
7	01-6 C4-6	SWPK 3P-RED		59	I3-5	IFJ-9U	INPUT 21
8	01-7 C4-7	SWPK 3P-YEL		60	I3-6	IFI-9U	INPUT 22
9	01-8 C4-8	SWPK 3P-GRN		61	I3-7	IFJ-9L	INPUT 23
10	02-1 C4-9	SWPK 2P-RED		62	I3-8	IFI-9L	INPUT 24
11	02-2 C4-10	SWPK 2P-GRN		63	I4-5	IFI-3U	INPUT 25
12	02-3 C4-11	SWPK 2P-RED		64	I4-6	IFJ-3U	INPUT 26
13	02-4 C4-12	SWPK 2P-YEL		65	I4-7	IFI-7U	INPUT 27
14	DCGND IFI	INPUT DCGND		66	I4-8	IFJ-7U	INPUT 28
15	02-5 C4-13	SWPK 2P-GRN		67	I5-1	IFI-12U	INPUT 29
16	02-6 C4-14	SWPK 1P-RED		68	I5-2	IFI-13U	INPUT 30
17	02-7 C4-15	SWPK 1P-YEL		69	I5-3	IFI-12L	INPUT 31
18	02-8 C4-16	SWPK 1P-GRN		70	I5-4	IFI-13L	INPUT 32
19	03-1 C4-17	SWPK 8P-RED		71	I5-5	IFJ-12U	INPUT 33
20	03-2 C4-18	SWPK 8P-GRN		72	I5-6	IFJ-13U	INPUT 34
21	03-3 C4-19	SWPK 8P-RED		73	I5-7	IFJ-12L	INPUT 35
22	03-4 C4-20	SWPK 8P-YEL		74	I5-8	IFJ-13L	INPUT 36
23	03-5 C4-21	SWPK 8P-GRN		75	I6-1	IFI-11L	INPUT 37
24	03-6 C4-22	SWPK 7P-RED		76	I6-2	IFI-3L	INPUT 38
25	03-7 C4-23	SWPK 7P-YEL		77	I6-3	IFJ-3L	INPUT 39
26	03-8 C4-24	SWPK 7P-GRN		78	I6-4	IFI-7L	INPUT 40
27	04-1 C4-25	SWPK 6P-RED		79	I6-5	IFJ-7L	INPUT 41
28	04-2 C4-26	SWPK 6P-GRN		80	I6-6	IFI-11U	INPUT 42
29	04-3 C4-27	SWPK 6P-RED		81	I6-7	IFI-14U	INPUT 43
30	04-4 C4-28	SWPK 6P-YEL		82	I6-8	IFI-14L	INPUT 44
31	04-5 C4-29	SWPK 6P-GRN		83	06-1	C5-1	NA
32	04-6 C4-30	SWPK 5P-RED		84	06-2	C5-2	NA
33	04-7 C4-31	SWPK 5P-YEL		85	06-3	C5-3	NA
34	04-8 C4-32	SWPK 5P-GRN		86	06-4	C5-4	NA
35	05-1 C4-33	SWPK 2P-YEL		87	06-5	C5-5	NA
36	05-2 C4-34	SWPK 6P-YEL		88	06-6	C5-6	NA
37	05-3 C4-35	SWPK 4P-YEL		89	06-7	C5-7	NA
38	05-4 C4-36	SWPK 8P-YEL		90	06-8	C5-8	NA
39	I1-1 IFI-2U	INPUT 1		91	07-1	C5-9	NA
40	I1-2 IFJ-2U	INPUT 2		92	DCGROUND	DC GND BUS	
41	I1-3 IFI-6U	INPUT 3		93	07-2	C5-10	NA
42	I1-4 IFJ-6U	INPUT 4		94	07-3	C5-11	NA
43	I1-5 IFI-2L	INPUT 5		95	07-4	C5-12	NA
44	I1-6 IFJ-2L	INPUT 6		96	07-5	C5-13	NA
45	I1-7 IFI-6L	INPUT 7		97	07-6	C5-14	NA
46	I1-8 IFJ-6L	INPUT 8		98	07-7	C5-15	NA
47	I2-1 IFI-4U8L	INPUT 9		99	07-8	C5-16	NA
48	I2-2 IFJ-4U8L	INPUT 10		100	05-5	C5-17	NA
49	I2-3 IFI-8U8L	INPUT 11		101	05-6	C5-18	NA
50	I2-4 IFJ-8U8L	INPUT 12		102	05-7	I Files	DETECTOR RESET
51	I2-5 IFJ-14U	INPUT 13		103	05-8	C4-37	WATCHDOG TIMER
52	I2-6 IFJ-14L	INPUT 14		104	DCGROUND IFI	INPUT DC GND	

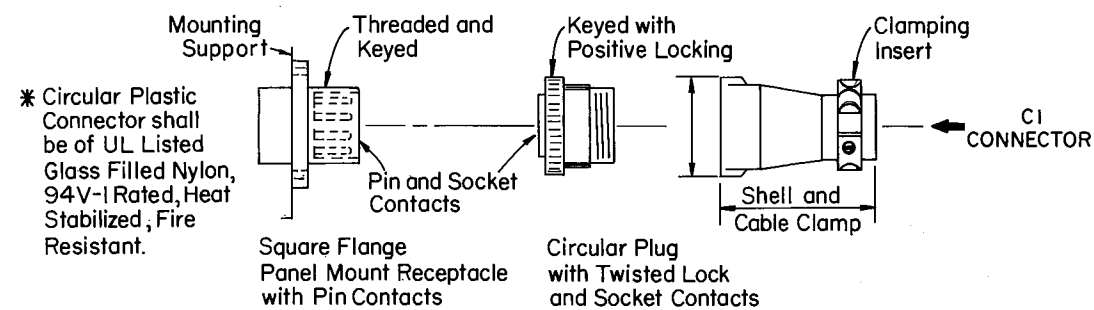
1F = INPUT FILE  
-14L = SLOT 14, CHANNEL 2

## CONNECTOR - C4 WIRING LIST

PIN	SOURCE (SOCKET)	DEST. (PLUG)	PIN	SOURCE (SOCKET)	DEST. (PLUG)
1	CI-2	SWPK 4P-6	19	CI-21	SWPK 8-6
2	CI-3	SWPK 4P-10	20	CI-22	SWPK 8-8
3	CI-4	SWPK 4-6	21	CI-23	SWPK 8-10
4	CI-5	SWPK 4-8	22	CI-24	SWPK 7-6
5	CI-6	SWPK 4-10	23	CI-25	SWPK 7-8
6	CI-7	SWPK 3-6	24	CI-26	SWPK 7-10
7	CI-8	SWPK 3-8	25	CI-27	SWPK 6P-6
8	CI-9	SWPK 3-10	26	CI-28	SWPK 6P-10
9	CI-10	SWPK 2P-6	27	CI-29	SWPK 6-6
10	CI-11	SWPK 2P-10	28	CI-30	SWPK 6-8
11	CI-12	SWPK 2-6	29	CI-31	SWPK 6-10
12	CI-13	SWPK 2-8	30	CI-32	SWPK 5-6
13	CI-15	SWPK 2-10	31	CI-33	SWPK 5-8
14	CI-16	SWPK 1-6	32	CI-34	SWPK 5-10
15	CI-17	SWPK 1-8	33	CI-35	SWPK 2P-8
16	CI-18	SWPK 1-10	34	CI-36	SWPK 6P-8
17	CI-19	SWPK 8P-6	35	CI-37	SWPK 4P-8
18	CI-20	SWPK 8P-10	36	CI-38	SWPK 8P-8
			37	CI-103	WD TIMER-MU22

## CONNECTOR - C5 WIRING LIST

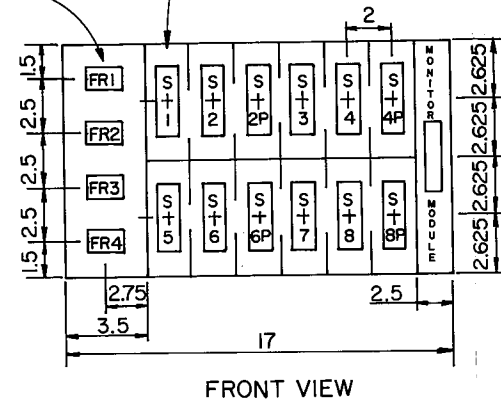
PIN	SOURCE (SOCKET)	DEST. (PLUG)	PIN	SOURCE (SOCKET)	DEST. (PLUG)
1	CI-83	NC	13	CI-96	NC
2	CI-84	NC	14	CI-97	NC
3	CI-85	NC	15	CI-98	NC
4	CI-86	NC	16	CI-99	NC
5	CI-87	NC	17	CI-100	NC
6	CI-88	NC	18	CI-100	NC
7	CI-89	NC	19	NC	NC
8	CI-90	NC	20	NC	NC
9	CI-91	NC	21	NC	NC
10	CI-93	NC	22	NC	NC
11	CI-94	NC	23	NC	NC
12	CI-95	NC	24	+24 VDC	NC



CONNECTORS C4 and C5

Top of relays shall be flush with face of file.

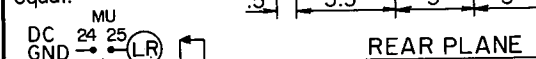
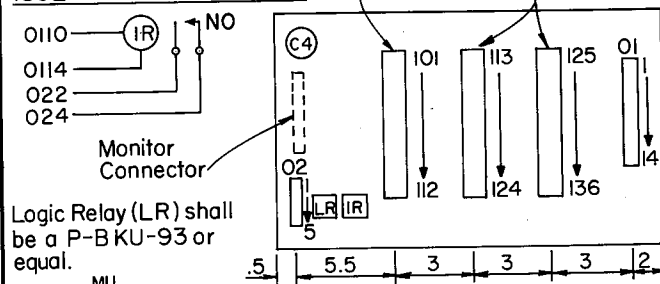
Flasher Transfer Relays and Switch Pack Socket Locations are Typical.



### TERMINAL BLOCK SCHEDULE

- O1 1- Power Ckt #1 SP. 1, 2, 2P  
2- Power Ckt #2 SP. 3, 4, 4P  
3- Power Ckt #3 SP. 5, 6, 6P  
4- Power Ckt #4 SP. 7, 8, 8P  
5- Flasher Unit 1 Ckt 1  
6- Flasher Unit 1 Ckt 2  
7- Flasher Unit 2 Ckt 1  
8- Flasher Unit 2 Ckt 2  
9- Equip. Gnd.  
10- AC-  
11- AC+  
12- MC 2 Coil  
13- Door Switch  
14- FT Relay Coil
- O2 1- +24VDC  
2- DC Gnd.  
3- Stop Time  
4- Flash Sense  
5- Ext. Reset

### ISOLATION RELAY DETAIL



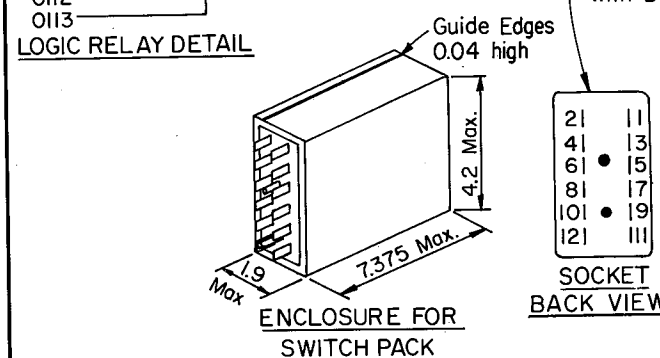
Logic Relay (LR) shall be a P-B KU-93 or equal.

DC 24 25  
GND

+24VDC

O112  
O113

LOGIC RELAY DETAIL



### OUTPUT FILE DETAIL

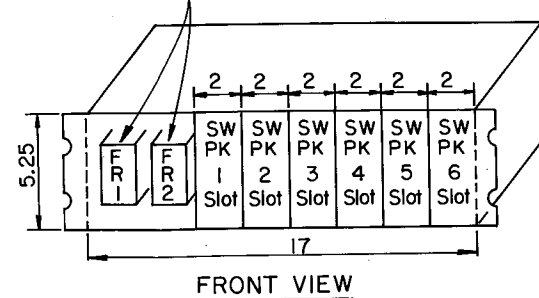
SWITCHPACK OUTPUTS FROM THE OUTPUT FILE SHALL CONNECT TO THE FOLLOWING FIELD TERMINALS:

### SWITCH PACK FIELD TERMINALS

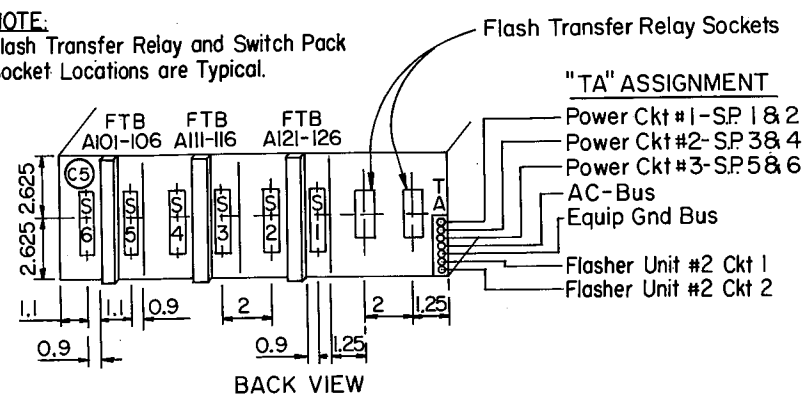
FIELD TERM.	FUNCTION	FIELD TERM.	FUNCTION	FIELD TERM.	FUNCTION
101	SWPK 4- RED	113	SWPK 2P- RED	125	SWPK 1- RED
102	SWPK 4- YEL	114	SWPK 2P- YEL	126	SWPK 1- YEL
103	SWPK 4- GRN	115	SWPK 2P- GRN	127	SWPK 1- GRN
104	SWPK 4P- RED	116	SWPK 3- RED	128	SWPK 2- RED
105	SWPK 4P- YEL	117	SWPK 3- YEL	129	SWPK 2- YEL
106	SWPK 4P- GRN	118	SWPK 3- GRN	130	SWPK 2- GRN
107	SWPK 8- RED	119	SWPK 6P- RED	131	SWPK 5- RED
108	SWPK 8- YEL	120	SWPK 6P- YEL	132	SWPK 5- YEL
109	SWPK 8- GRN	121	SWPK 6P- GRN	133	SWPK 5- GRN
110	SWPK 8P- RED	122	SWPK 7- RED	134	SWPK 6- RED
111	SWPK 8P- YEL	123	SWPK 7- YEL	135	SWPK 6- YEL
112	SWPK 8P- GRN	124	SWPK 7- GRN	136	SWPK 6- GRN

### OUTPUT FILE TERMINAL ASSIGNMENT DETAIL

Top of relays shall be flush with face of file.



NOTE:  
Flash Transfer Relay and Switch Pack Socket Locations are Typical.



SWITCHPACK OUTPUTS FROM THE AUXILIARY OUTPUT FILE SHALL CONNECT TO THE FOLLOWING FIELD TERMINALS.

### SWITCH PACK FIELD TERMINALS

FIELD TERM.	FUNCTION	FIELD TERM.	FUNCTION	FIELD TERM.	FUNCTION
A101	SWPK 5- RED	A111	SWPK 3- RED	A121	SWPK 1- RED
A102	SWPK 5- YEL	A112	SWPK 3- YEL	A122	SWPK 1- YEL
A103	SWPK 5- GRN	A113	SWPK 3- GRN	A123	SWPK 1- GRN
A104	SWPK 6- RED	A114	SWPK 4- RED	A124	SWPK 2- RED
A105	SWPK 6- YEL	A115	SWPK 4- YEL	A125	SWPK 2- YEL
A106	SWPK 6- GRN	A116	SWPK 4- GRN	A126	SWPK 2- GRN

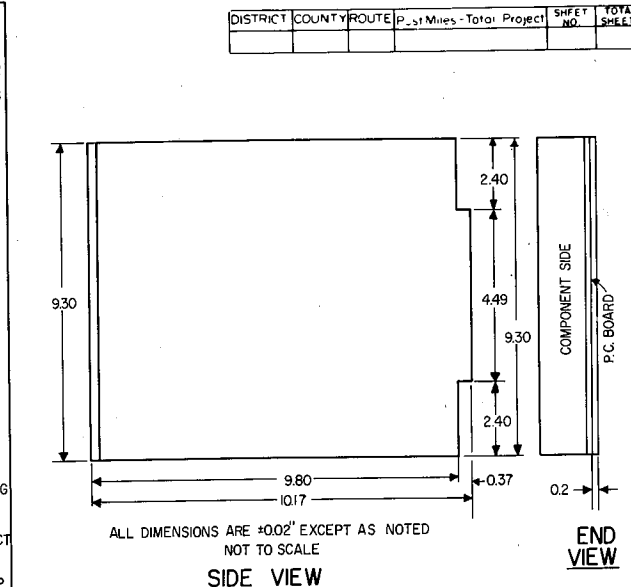
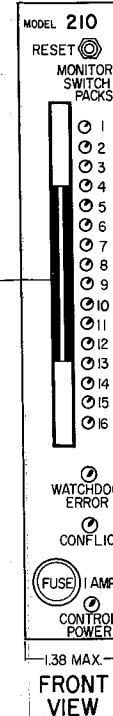
### AUXILIARY OUTPUT FILE DETAIL

### C5 PLUG CONNECTOR ASSIGNMENT

PINS	DESTINATION	PINS	DESTINATION
1	SWPK 6-Pin 6	13	SWPK 2-Pin 10
2	SWPK 6-Pin 10	14	SWPK 1-Pin 6
3	SWPK 5-Pin 6	15	SWPK 1-Pin 8
4	SWPK 5-Pin 8	16	SWPK 1-Pin 10
5	SWPK 5-Pin 10	17	SWPK 6-Pin 8
6	SWPK 4-Pin 6	18	SWPK 3-Pin 8
7	SWPK 4-Pin 8	19	NC
8	SWPK 4-Pin 10	20	NC
9	SWPK 3-Pin 6	21	NC
10	SWPK 3-Pin 10	22	NC
11	SWPK 2-Pin 6	23	NC
12	SWPK 2-Pin 8	24	Pin 9, All Sockets

NOTES: (This Sheet)

1. All dimensions shown are in inches.

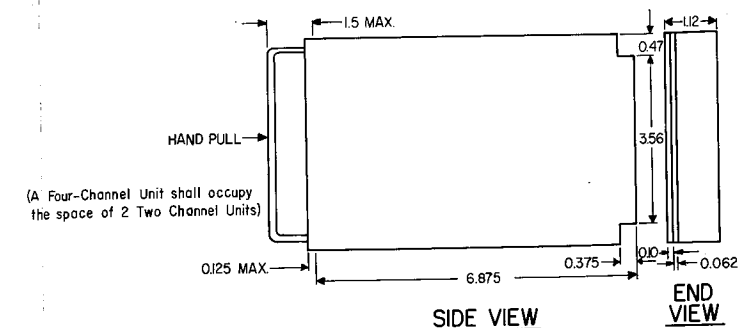


### MODEL 210 MONITOR UNIT

### MODEL 210 MONITOR UNIT PIN ASSIGNMENT

CONNECTOR PIN NO.	MONITOR FUNCTION	TERMINATION	CONNECTOR PIN NO.	MONITOR FUNCTION	TERMINATION
1	SWPK 2 GRN		A	SWPK 2 YEL	
2	SWPK 2P GRN		B	SWPK 6 GRN	
3	SWPK 6 YEL		C	SWPK 6P GRN	
4	SWPK 4 GRN		D	SWPK 4 YEL	
5	SWPK 4P GRN		E	SWPK 8 GRN	
6	SWPK 8 YEL		F	SWPK 8P GRN	
7	SWPK 5 GRN		H	SWPK 5 YEL	
8	T & B		J	SWPK 1 GRN	
9	SWPK 1 YEL		K	T & B	
10	SWPK 7 GRN		L	SWPK 7 YEL	
11	T & B		M	SWPK 3 GRN	
12	SWPK 3 YEL		N	T & B	
13	SWPK 2P YEL		P	NA	
14	NA		R	SWPK 6P YEL	
15	T & B		S	T & B	
16	SWPK 4P YEL		T	NA	
17	NA		U	SWPK 8P YEL	
18	T & B		V	T & B	
19	NA		W	NA	
20	EQ GND	O1-9	X	NA	
21	AC-	O1-10	Y	DC GROUND	O2-2
22	WATCHDOG TIMER	C4-37	Z	EXTERNAL RESET	O2-5
23	+24VDC	O2-1	AA	T & B	
24	BD. OUT CKT	LOGIC RELAY COIL	BB	STOP TIME	O2-3
25	BD. OUT CKT	DC GROUND	CC	NA	
26	NA		DD	NA	
27	NA		EE	OUTPUT SW-SIDE 2	O1-12
28	OUTPUT-SW SIDE 1 AC+		FF	AC+	O1-11

X keyed  
T & B - Conductor connected to pin, two feet in length with ring lug on unconnected end, bundled and tied separately.



### DETAIL FOR MODELS 222, 224, 228, 232, 234, 242, 244, 252

NO SCALE

CABINET CONNECTOR DETAILS  
QUALITY EQUIPMENT

CONNECTOR C1P AND C1S											
PIN	SOURCE	FUNCTION	PIN	SOURCE	FUNCTION	PIN	SOURCE	FUNCTION	PIN	SOURCE	FUNCTION
1	DC Grd	DC Ground	27	04-1	NC	53	12-7	NC	79	16-5	IF-10H
2	01-1	SW PK1-Red	28	04-2	NC	54	12-8	NC	80	16-6	IF-9L
3	01-2	SW PK1-Grn	29	04-3	NC	55	13-1	IF-4U	81	16-7	IF-9U
4	01-3	SW PK2-Red	30	04-4	NC	56	13-2	IF-4L	82	16-8	NC 10L
5	01-4	SW PK2-Yel	31	04-5	NC	57	13-3	IF-6U	83	06-1	C5-1
6	01-5	SW PK2-Grn	32	04-6	NC	58	13-4	IF-6L	84	06-2	C5-2
7	01-6	SW PK3-Red	33	04-7	NC	59	13-5	IF-7U	85	06-3	C5-3
8	01-7	SW PK3-Yel	34	04-8	NC	60	13-6	IF-7L	86	06-4	C5-4
9	01-8	SW PK3-Grn	35	05-1	NC	61	13-7	IF-9U	87	06-5	C5-5
10	02-1	NC	36	05-2	NC	62	13-8	IF-9L	88	06-6	C5-6
11	02-2	NC	37	05-3	NC	63	14-5	NC	89	06-7	C5-7
12	02-3	NC	38	05-4	NC	64	14-6	NC	90	06-8	C5-8
13	02-4	NC	39	11-1	IF-1L	65	14-7	Pol Cont'l SW	91	07-1	C5-9
14	DC Grd	DC Grd-IF	40	11-2	IF-12L	66	14-8	Pol Lights SW	92	DC Grd	Output Grd
15	02-5	NC	41	11-3	IF-12U	67	15-1	NC	93	07-2	C5-10
16	02-6	NC	42	11-4	IF-13L	68	15-2	NC	94	07-3	C5-11
17	02-7	NC	43	11-5	IF-13U	69	15-3	NC	95	07-4	C5-12
18	02-8	NC	44	11-6	IF-14L	70	15-4	NC	96	07-5	C5-13
19	03-1	NC	45	11-7	IF-14U	71	15-5	NC	97	07-6	C5-14
20	03-2	NC	46	11-8	IF-15L	72	15-6	NC	98	07-7	C5-15
21	03-3	NC	47	12-1	IF-2L	73	15-7	NC	99	07-8	C5-16
22	03-4	NC	48	12-2	IF-3L	74	15-8	NC	100	05-5	C5-17
23	03-5	NC	49	12-3	IF-3U	75	16-1	NC	101	05-6	C5-18
24	03-6	NC	50	12-4	IF-2U	76	16-2	NC	102	05-7	Det Reset
25	03-7	NC	51	12-5	IF-5U	77	16-3	NC	103	05-8	Watchdog
26	03-8	NC	52	12-6	IF-5L	78	16-4	NC	104	DC Grd	Input Grd

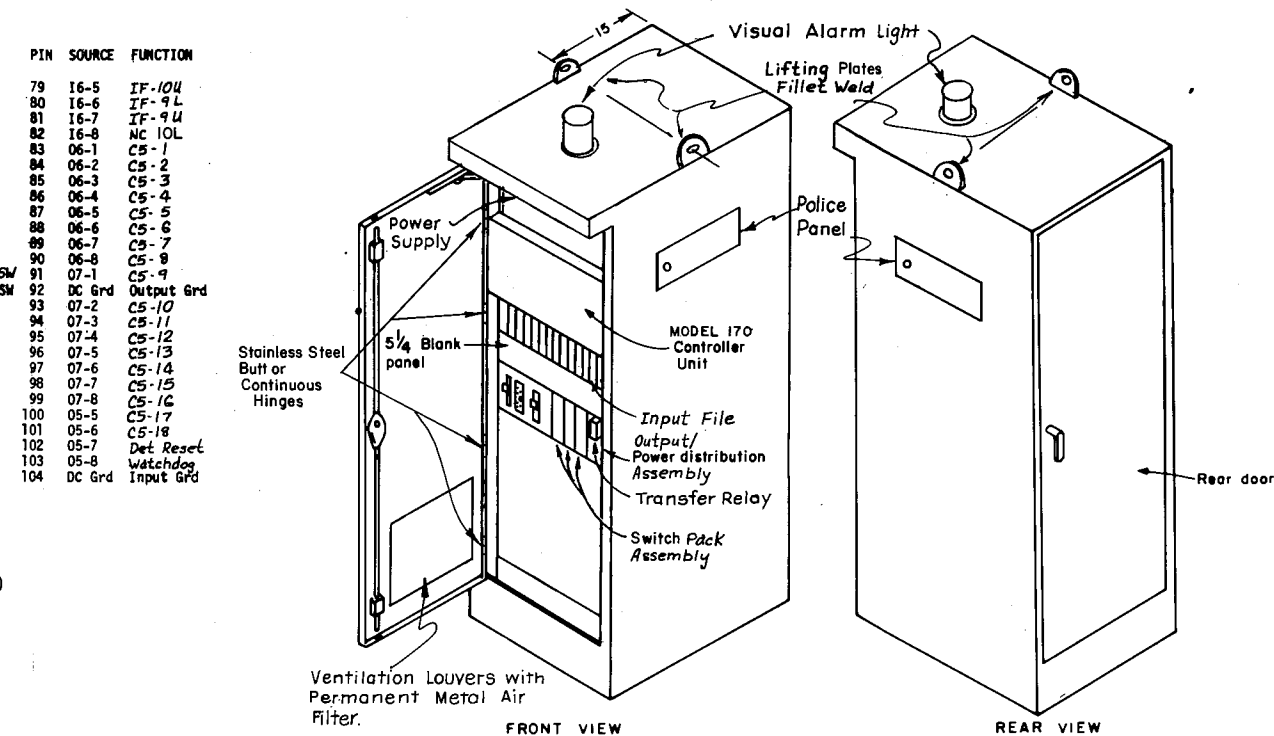
CONNECTOR - C4 WIRING LIST											
PIN	SOURCE (SOCKET)	DEST. (PLUG)	PIN	SOURCE (SOCKET)	DEST. (PLUG)	PIN	SOURCE (SOCKET)	DEST. (PLUG)	PIN	SOURCE (SOCKET)	DEST. (PLUG)
1	C1-2	SWPK 1-6	13	NC	NC	21	NC	NC	33	NC	NC
2	C1-3	SWPK 1-10	14	NC	NC	22	NC	NC	34	NC	NC
3	C1-4	SWPK 2-6	15	NC	NC	23	DC GND	Watchdog Timer	35	NC	NC
4	C1-5	SWPK 2-8	16	NC	NC	24	+24 VDC	SWPK 1-9	36	NC	NC
5	C1-6	SWPK 2-10	17	NC	NC						
6	C1-7	SWPK 3-6	18	NC	NC						
7	C1-8	SWPK 3-8	19	NC	NC						
8	C1-9	SWPK 3-10	20	NC	NC						
9	C1-37	SWPK 1-8	21	NC	NC						
10	C1-103	Watchdog Timer	22	NC	NC						
11	NC	NC	23	DC GND	Watchdog Timer						
12	NC	NC	24	+24 VDC	SWPK 1-9						

CONNECTOR - C5 WIRING LIST											
PIN	SOURCE (SOCKET)	DEST. (PLUG)	PIN	SOURCE (SOCKET)	DEST. (PLUG)	PIN	SOURCE (SOCKET)	DEST. (PLUG)	PIN	SOURCE (SOCKET)	DEST. (PLUG)
1	C1-83	NC	13	C1-96	NC	21	NC	NC	33	NC	NC
2	C1-84	NC	14	C1-97	NC	22	NC	NC	34	NC	NC
3	C1-85	NC	15	C1-98	NC	23	NC	NC	35	NC	NC
4	C1-86	NC	16	C1-99	NC	24	+24 VDC	NC	36	NC	NC
5	C1-87	NC	17	C1-100	NC						
6	C1-88	NC	18	C1-101	NC						
7	C1-89	NC	19	NC	NC						
8	C1-90	NC	20	NC	NC						
9	C1-91	NC	21	NC	NC						
10	C1-93	NC	22	NC	NC						
11	C1-94	NC	23	NC	NC						
12	C1-95	NC	24	+24 VDC	NC						

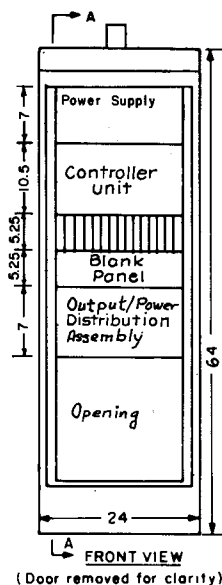
# NOTES (THIS SHEET)

- All dimensions shown are in inches
- For details on the following cabinet items see the Associated Plans under this Chapter:

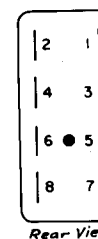
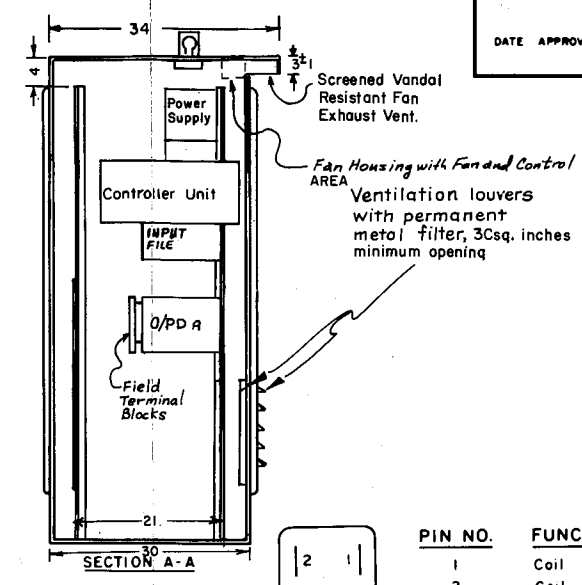
ITEM	PLAN
C1P Connector	MODEL 170 CONTROLLER UNIT
Cabinet Base	MODEL 332 CABINET DETAILS
Door Fabrication	" " " "
Cabinet Pallet	" " " "
Input File	" " " "
C4 & C5 Connectors	MODEL 332 CABINET CONNECTOR DETAILS



CABINET  
No Scale  
Equipment Layout



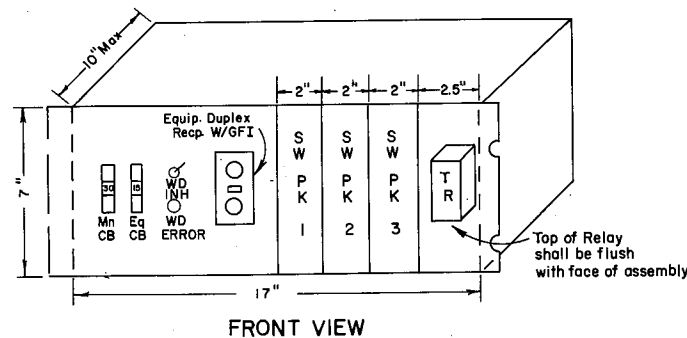
CABINET DETAILS  
No Scale  
Dimension tolerance  $\pm \frac{1}{8}$



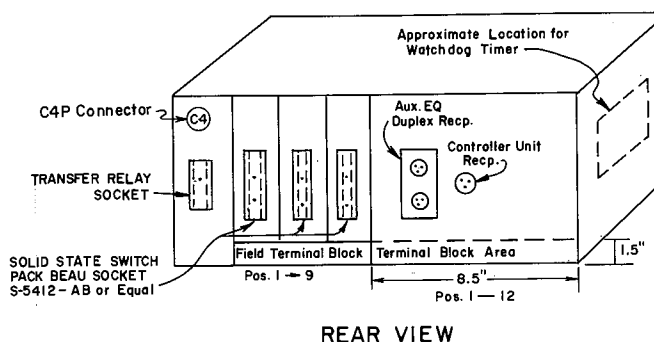
PIN NO.	FUNCTION
1	Coil
2	Coil
3	N.C. Circuit #1
4	N.C. Circuit #2
5	Common Circuit #1
6	Common Circuit #2
7	N.O. Circuit #1
8	N.O. Circuit #2

# TRANSFER RELAY SOCKET (Flash Transfer where applicable)

No Scale  
BEAU SOCKET \*S5408-AB OR EQUAL



FRONT VIEW



REAR VIEW

TERMINAL BLOCK ASSIGNMENTS											
FIELD TERMINAL BLOCK						ASSEMBLY CABINET BLOCK					
FIELD		TERMINAL		BLOCK		FIELD		TERMINAL		BLOCK	
A(ext)	B (Int)	Pos	A(ext)	B (Int)	Pos.	A (ext)	B (Int)	Pos.	A (ext)	B (Int)	Pos.
Alarm Lit	SWPK 3-3	7	Field SWPK 1-3	AC	1	Eq.Gnd.Bus	EGnd	7	SPARE	SPARE	
Field SWPK 3-5	8	Field SWPK 1-5	AC	8	2 AC-Bus	AC	8	SPARE	SPARE		
Field SWPK 3-7	9	Field SWPK 1-7	AC	9	InFile I, Fan	Main(Sec)	9	SPARE	SPARE		
Field SWPK 2-3	10	Field SWPK 1-10	AC	10	Power Supply	Main(Sec)	10	SPARE	SPARE		
Field SWPK 2-5	11	Field SWPK 1-11	AC	11	Police Lights	WDT	11	SPARE	SPARE		
Field SWPK 2-7	12	Field SWPK 1-12	AC	12	Switch	TR Coil	12	SPARE	SPARE		

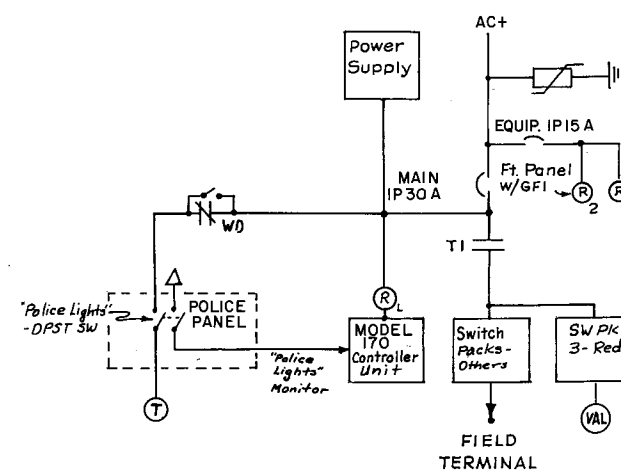
# LEGEND

4D - File Slot 4; Pin D (Input File)  
O/PDA - Output/Power Viot. Assembly

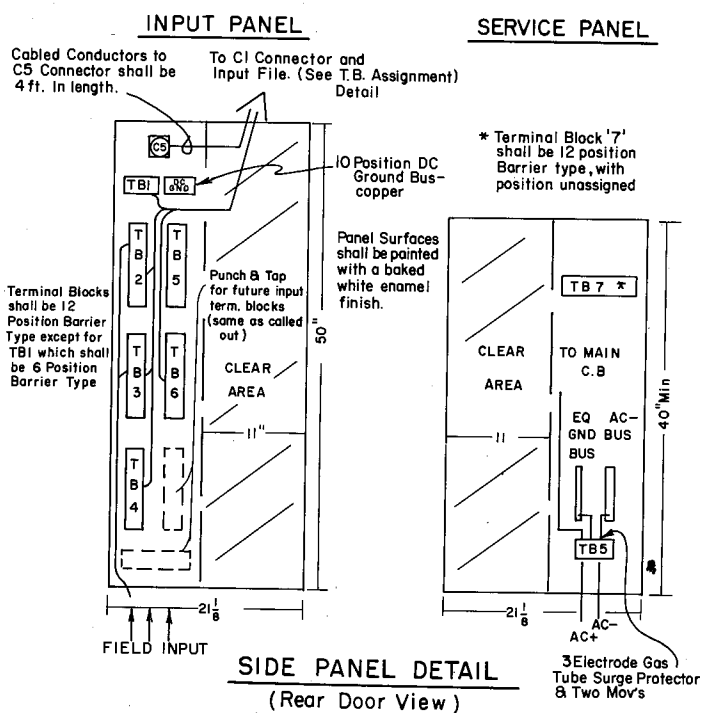
# OUTPUT/POWER DISTRIBUTION ASSEMBLY DETAIL

POSITION	A	B	POSITION	A	B	POSITION	A	B
TB1-1	+24VDC	IF,C4,C5	TB3-1	Det 7	4D	TB5-1	Det 19	10D
2	+24VDC	O/PDA	2	Det 8	4E	2	Det 20	10E
3	NA	NA	3	Det 9	4J	3	Det 21	10J
4	NA	NA	4	Det 10	4K	4	Det 22	10K
5	NA	NA	5	Det 11	5D	5	Det 23	11D
6	NA	NA	6	Det 12	5E	6	Det 24	11E
			7	Det 13	5J	7	Det 25	11J
			8	Det 14	5K	8	Det 26	11K
			9	Det 15	6D	9	Det 27	12D
			10	Det 16	6E	10	Det 28	12E
			11	Det 17	6J	11	Det 29	12J
			12	Det 18	6K	12	Det 30	12K

# PANEL TERMINAL BLOCK ASSIGNMENT DETAIL



CABINET ONE LINE DIAGRAM



SIDE PANEL DETAIL  
(Rear Door View)

# MODEL 334 CONTROLLER CABINET DETAILS

CHAPTER 2  
SPECIFICATIONS FOR CONTROLLER UNIT  
MODEL 170

This Chapter defines the specifications applicable to the Model 170 controller unit. These specifications shall supplement the General Specifications for Traffic Signal Equipment and in case of conflict the specifications of this Chapter shall govern.

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SPECIFICATIONS FOR CONTROLLER UNIT,  
MODEL 170

SECTION I

CONTROLLER UNIT REQUIREMENTS

1. Microprocessor Unit (MPU)

- 1.1 The controller unit shall properly execute existing State-owned object programs developed to operate with a Motorola 6800 Microprocessor Unit.

2. Controller Unit Clock Timing

- 2.1 The controller unit shall have clock timing whose frequency is 768 kilohertz  $\pm 0.1$  percent. The machine cycle time shall be approximately 1.302 microseconds.

3. Input-Output Interface

- 3.1 The input-output interface shall utilize a ground true logic. The transfer of data between interface and working registers within the MPU shall be in 8-bit word increments, minimum. The steering of data from inputs or outputs for a given address shall be controlled by the state of the MPU read/write command at the time the given address is valid.

3.2 Output Interface

- 3.2.1 The output interface shall consist of a minimum of 80 bits of buffered storage. Output data shall be latched at the time of writing from the MPU. This interface shall provide an NPN open collector output capable of driving up to 30 volts DC and sinking up to 40 milliamperes. The output may be a TTL 7406 open collector inverter. A one from the MPU shall be presented as a grounded collector, and a zero presented as an open circuit. Once a port is written into, the data shall remain present and stable until either another word is written into it or until the power is turned off. The state of these output ports at the time of power up or below power failure threshold shall be an open circuit.

### 3.3 Input Interface

- 3.3.1 The input interface shall consist of a minimum of 64 bits of gated inputs from external devices. Each logic level input shall be turned ON (true) when the input voltage is less than 3.5 volts, shall be turned OFF (false) when the input current is less than 100 microamperes or the input voltage exceeds 8.5 volts, shall pull up to 12 Volts DC, and shall not deliver in excess of 20 milliamperes to a short circuit to logic level common. When the appropriate input address is impressed upon the input interface, the interface shall place its data on the data bus, which will be read by the MPU. Ground on any input shall be interpreted by the MPU as a "one" and an open on any input or the presence of a voltage greater than 8.5 Volts shall be interpreted as a "zero" by the MPU when that input is read.

### 4. System Address Organization

- 4.1 The system addressing plan for the controller unit shall be as shown on the plans.

### 5. Downtime Accumulator (DTA)

- 5.1 A Downtime Accumulator shall be provided to accumulate time during power failures. Upon restoration of power, the DTA shall present two 8-bit data inputs indicating the number of minutes and seconds of power failure with an accuracy of  $\pm 1$  second over the 255 minute range of the DTA. The DTA shall indicate all ones on the Minutes Register for power failures greater than 255 minutes.
- 5.2 The DTA shall reset both 8 bit registers to zero by writing to Address 5000, and shall read by reading from Address 5000 for Minutes and Address 500F for Seconds. The Seconds Register shall utilize Bits 1 through 6 to count 0 to 59 seconds.

### 6. Traffic PROM Module

- 6.1 The Traffic PROM Module Board Dimensions, Contact Assignments and Space Requirements shall comply with the details shown on the plans.

- 6.2 All electrical connections in and out of the module shall be through a printed circuit connector having two rows of 36 independent bifurcated contacts on 0.100-inch centers.
- 6.3 See "Electrical Requirements" of this Chapter for the allowable power requirements for the Traffic PROM Module.
- 6.4 The module shall be designed so that persons inserting or removing the module will not be required to insert hands or fingers within the controller unit housing. The front of the module shall be flush with the front of the controller unit. The front panel shall be connected to equipment ground.
- 6.5 The module shall be provided with a handle or gripping device secured to the front panel of the module and protruding no more than 1-1/4 inches.
- 6.6 All Data Outputs shall be tri-state buffered devices enabling them to drive a load consisting of 10 TTL gates and 200 picofarads. When the PROM Module is not being addressed, the data outputs shall be disabled into a high impedance state and the outputs shall not source or sink more than 100 microamperes. All Address Inputs shall not load the bus by more than 1 TTL gate load and 100 picofarads.
- 6.7 The PROM module shall provide 8192 8-bit words of memory. Each PROM chip shall be electrically programmable and shall be erasable by exposure to ultraviolet radiation. This memory shall be nonvolatile and shall not be affected by transients resulting from power switching and external loading and unloading conditions. The PROM chips shall be the INTEL 2708, Motorola MCM 68708, Signetics SN 2708, or equivalent. Sockets for PROM Chips shall be properly marked on the board adjacent to the socket as to the lowest address to ensure correct chip mating with its associated socket.

## 7. RAM Memory

- 7.1 RAM Memory shall be a minimum of 1,024 eight-bit words. The RAM shall have a read and write time suitable to perform either function in one MPU instruction cycle. The RAM shall be static and alterable by word. The RAM shall retain full memory for a

minimum of 30 days in the controller unit with AC power off, and for a minimum of 4 hours out of controller unit.

- 7.2 A Hold-Up Battery shall be provided on the board housing the RAM Memory to maintain the program in the RAM when the board is removed from the controller unit. The battery shall be a nickel-cadmium type, or equivalent with a rated capacity of 150 milliampere hours.

## 8. Communication System Components

- 8.1 The components of the communication system required as part of the Model 170 Controller Unit include an asynchronous communications interface adapter (ACIA); space, power, mounting facilities, and a connector for installation of a Model 400 MODEM within the controller unit; and Connector 2 and Terminal Block T1.
- 8.2 The purpose of the communication system is to provide for bi-directional communications from a controller unit to another controller unit at a different location over standard 3002 voice grade telephone lines, or equivalent. The communication system shall be capable of both two wire, half-duplex operation and four wire, full-duplex operation.
- 8.3 The ACIA shall be capable of receiving and transmitting up to eight-bits of data from the MPU for serial data communications. The ACIA shall have four registers which may be addressed by the MPU. The MPU shall be capable of reading the status register (SR) and the receiver data register (RDR), and writing in the transmit data register (TDR) and in the control register (CR). The interface between the ACIA and the Model 400 Modern shall comply with EIA-RS-232-C Standards.
  - 8.3.1 The MPU shall be able to read the converted serial to parallel data on the RDR by addressing Location 6001.
  - 8.3.2 The MPU shall be able to store data in the TDR for parallel to serial conversion by addressing Location 6001.
  - 8.3.3 The SR shall be read by the MPU by addressing Location 6000. The SR shall comply with the following bit requirements.

## STATUS REGISTERS (SR)

8	7	6	5	4	3	2	1
IRQ	PE	ROV	FE	CTS	DCD	TDRE	RDRF

### Bit 1 - Receiver Data Register Full (RDRF)

"1" - The Receiver Data Register is full.

"0" - The Receiver Data Register has been read by the MPU.

### Bit 2 - Transmit Data Register Empty (TDRE)

"1" - The Transmit Data Register is empty and new data may be transferred.

"0" - The Transmit Data Register is full.

### Bit 3 - Data Carrier Detect (DCD)

"1" - There is no carrier from the MODEM.

"0" - The carrier from the MODEM is present.

### Bit 4 - Clear to Send (CTS)

"1" - MODEM is not ready for data.

"0" - MODEM is ready for data.

### Bit 5 - Framing error (FE)

"1" - Framing error indicates that the received character is improperly framed by the start and stop bit and indicates a synchronization error, faulty transmission, or a break condition.

"0" - The received character is properly framed.

### Bit 6 - Receiver Overrun (ROV)

"1" - Overrun is an error flag that indicates that one or more characters in the data stream were lost.

"0" - No Receiver Data Overrun have occurred.

Bit 7 - Parity Error (PE)

"1" - The parity error flag indicates that the number of highs (ones) in the character does not agree with the presented odd or even parity.

"0" - No parity error occurred.

Bit 8 - Interrupt Request (IRQ)

"1" - There is an interrupt in the ACIA.

"0" - No interrupt present.

8.3.4 Space for the MODEM shall be provided in the controller unit conforming to the details shown on the plans.

8.3.5 Card guides shall be provided for the MODEM board.

8.3.6 See "Electrical Requirements" of this Chapter for MODEM power requirements.

8.3.7 All electrical connections in and out of the MODEM module shall be through a printed circuit connector having 2-rows of 22 independent bifurcated contacts on 0.156-inch centers.

Connector contact assignments shall be as shown on the plans.

8.3.8 The MPU shall write into the CR by addressing Location 6000. The CR shall comply with the following bit requirements:

CONTROL REGISTER (CR)

8	7	6	5	4	3	2	1
Receiver	Transmitter		Word			Counter	
Interrupt	Control		Select			Divide	
Enable							

Bit 1 and 2 - Counter Divide Select Bits (CDS)

A baud rate of 300 shall result when bit 1 is set to a logic 0, while bit 2 is set to a logic 1.

A baud rate of 1200 shall result when bit 1 is set to a logic 1, while bit 2 is set to a logic 0.

Bit 3, 4, 5 - Word Select Bits (WS)

<u>CR5</u>	<u>CR4</u>	<u>CR3</u>	<u>FUNCTION</u>	
0	0	0	7 Bit + EP + 2SB	
0	0	1	7 Bit + OP + 2SB	EP - Even Parity
0	1	0	7 Bit + EP + 1SB	OP - Odd Parity
0	1	1	7 Bit + OP + 1SB	SB - Stop bits
1	0	0	8 Bit + 2SB	
1	0	1	8 Bit + 1SB	
1	1	0	8 Bit + EP + 1SB	
1	1	1	8 Bit + OP + 1SB	

Bit 6 and 7 - Transmitter Control (TC)

<u>CR6</u>	<u>CR7</u>	<u>FUNCTION</u>
0	0	RTS = Low Transmitting Interrupt Disabled (TIE)
1	0	RTS = Low Transmitting Enabled (TIE)
0	1	RTS = High Transmitting Interrupt Disabled (TIE)
1	1	RTS = Low Transmitting Interrupt Disabled (TIE) and transmits a Break level on the transmit data output.

### Bit 8 - Receiver Interrupt Enable

"1" - Enables interrupts caused by

- a) Receiver Data Register Full going high
- b) A low to high transition on the Data Carrier Detect signal line

"0" - Cleared by selecting the Receiver Data Register or by resetting the Receiver Interrupt Enable Bit.

## 9. Standby Power

- 9.1 A Chassis Standby Battery shall be provided to power the Restart Timer, Downtime Accumulator, and to achieve nonvolatility in the RAM during power failure. The battery shall have sufficient capacity for a continuous backup requirement of 2 seconds for the Restart Timer, 255 minutes for the Downtime Accumulator Counting Circuits (Minutes Register shall be retained the same duration as RAM) and shall retain full RAM memory for a minimum of 30 days. Battery power shall be activated by a transfer circuit immediately upon sensing power failure. Battery float circuit is not acceptable.
- 9.2 The Chassis Standby battery shall be a sealed, fast rechargeable, lead-acid gel-cell type or equivalent suitable for standby operation. It shall be securely installed inside the controller unit chassis. The total weight of the standby battery shall not exceed 3 pounds. The battery shall have a minimum capacity rating of 2.5 ampere-hours.
- 9.3 A battery charging circuit shall be provided which will fully recharge and float both the Chassis Standby Battery and the RAM holdup battery consistent with battery manufacturer's recommendations. An indicator, located on the front panel, shall be provided which, when illuminated, indicates that the battery charging current exceeds a preset limit thereby indicating that the batteries are in a "High charge" mode.



## 10. Front Panel

- 10.1 The front panel shall be securely fastened to the chassis and removable without the need for tools. A continuous hinge shall be provided on the left side of the unit to permit opening of the front panel and ready access to the interior of the controller unit.
- 10.2 The front panel shall be electrically connected by means of Connector C3. The front panel shall be connected to equipment ground through Connector C3.
- 10.3 The Front Panel Layout shall be as shown on the plans. The character displays shall be hexadecimal with TTL circuits to accept, store, and display 4-bit binary data. The characters shall be 0.40-inch high, minimum. Each character shall have a latch strobe input and a blanking input. The second character from the right (lower row) shall have a right decimal point. The face of the character display shall be scratch and solvent-resistant. The transfer of data from the MPU through the output interface to the display shall result in the display of each character in its non-inverted state.
- 10.4 The front panel shall be provided with 10 indicators as shown on the plans.
- 10.5 A keyboard shall be provided as shown on the plans. The transfer of data from the keyboard by way of the input interface to the MPU shall result in each character being received in its non-inverted state. The character shall consist of 4-bits of binary data, while the character control shall consist of one bit. A low state on the character control to the interface shall indicate the presence of a valid character. Each key shall be engraved or embossed with its function character, shall have a minimum surface area of 0.075 square inches and shall be mounted on a minimum of 0.50-inch centers; shall have an actuation force between 50 and 100 grams and shall provide positive tactical indications of contact. Key contacts shall have a design life of over one million operations, shall be rated for the current and voltage levels used, and shall stabilize within five(5) milliseconds following contact opening.

- 10.6 The front panel shall be provided with a toggle switch to enable the stop timing function. The switch shall be of the miniature type rated for over one million operations at 120 volts and 0.25 ampere.
- 10.7 The front panel shall be provided with an ON-OFF toggle switch and fuse for AC power. The switch and fuse, shall not be attached to the front panel, but shall protrude through it. The ON-OFF toggle switch and fuse shall remain with the controller unit chassis when the front panel is removed. The fuse shall be a 3AG Type rated at 2 amperes.
- 10.8 The front panel, under the legend "OPERATING INSTRUCTIONS", shall include a framework to retain a card, 4 inches wide by 6 inches high by 1/16 inch thick.
- 10.9 The front panel shall provide an opening for the insertion and removal of the PROM module.

## 11. Power Supply

- 11.1 All DC power necessary to operate the controller unit shall be developed from within the unit.
- 11.2 Four internal DC Voltages, in addition to any other required voltages, shall be supplied to operate all internal circuitry of the controller unit. The power supply shall provide the following voltages and current.

<u>Module</u>	<u>Minimum Current (Milliamperes)</u>			
<u>DC Voltages</u>	+12	-12	+5	-5
MODEM	150	150	---	---
Traffic PROM	600	10	100	400

- 11.3 The DC ground shall not be connected to equipment ground.

## 12. Chassis

- 12.1 The controller unit shall be housed in a compact, portable metal enclosure suitably protected against corrosion. The enclosure shall be not more than

7" high, 14" deep including the male Connector C1, and shall be mountable in a 19" rack. The enclosure shall be designed for convenient removal of printed circuit boards without the use of tools.

- 12.2 Should the controller unit be equipped with a fan, thermal overload protection for the fan shall be provided.
- 12.3 The weight of the controller unit shall not exceed 25 pounds.

#### INTERRUPT REQUIREMENTS

The MPU shall recognize and execute the following interrupts.

##### 1. Non-Maskable Interrupt (NMI)

A power failure exceeding 50 milliseconds shall cause the MPU NMI line to go low. Power shall be held up for a minimum of 55 milliseconds following a power failure.

- 1.1 The Controller Unit shall be furnished with a Restart Timer whose output state is normally high. Upon initialization of the NMI, the Restart Timer shall begin timing. At the end of a period,  $1.75 \pm .25$  seconds, the Restart Timer Output shall go low and remain low for  $150 \pm 24$  milliseconds after power restoration. Should power be restored prior to time out, the Timer shall reset.

##### 2. Reset Interrupt (RES)

- 2.1 The RES Line shall delay going low for a minimum of 2 milliseconds following initiation of the NMI.
- 2.2 At the restoration of power, the RES Line shall remain low for  $100 \pm 24$  milliseconds.

##### 3. Interrupt Request (IRQ)

- 3.1 Real Time Clock (RTC) - The controller unit shall initiate a IRQ once every  $1/60$  of a second during the 0 to 150 degree portion of the negative alternation of the AC sine wave. The RTC Request shall be reset by writing to Address 5FFF.

- 3.2 An incoming signal from the MODEM via the Asynchronous Communications Interface Adapter (ACIA) shall initiate an IRQ.
- 4. Software Interrupt (SWI)
  - 4.1 A "Software Interrupt" shall be provided.
- 5. Wait for Interrupt (WAI)
  - A "Wait for Interrupt" interrupt shall be provided.

## SECTION II

### ELECTRICAL REQUIREMENTS

1. The front panel and chassis shall be connected to equipment ground.
2. A surge arrestor shall be provided between the AC+ and AC- for protection against powerline noise transients. The surge arrestor shall be capable of meeting the following requirements:

Recurrent peak voltage: 212 volts  
Energy rating maximum: 20 joules  
Power dissipation, average: 0.85 watt  
Peak current for pulses less than 6 microseconds: 2000 amperes  
Standby current: less than 1 milliamperes

- 2.1 A 1 ohm, 10 watt wire-wound power resistor shall be provided for protection of the surge arrestor.
3. The AC power to the controller unit shall be supplied by a 3 conductor cable at least 3 feet in length. The cable shall terminate in a NEMA Type 5-15P grounding type plug.
4. Test points shall be provided for monitoring all power supply voltages, and for checking the wave forms of both Phase 1 and Phase 2 clocks of the MPU. All test points shall be readily accessible when the front panel is opened and all p.c. boards are installed.
  - 4.1 Test point shall be a binder post or approved equal.

## SECTION III

### CONNECTOR REQUIREMENTS

1. Controller Unit Connector physical requirements and contact assignments shall be as shown on the plans and as detailed in this section.
2. All logic connections into or out of the controller unit shall be made through a 104 socket connector (Connector C1S).
  - 2.1 Contacts shall be beryllium copper construction, subplated with 0.00005-inch nickel and plated with 0.00003-inch gold. Sockets shall accept pin contacts 0.062-inch in diameter. The connector shall contain the socket contacts.
  - 2.2 Corner guide pin assemblies for pin connectors shall be stainless steel and shall be 1.097 inches in length. Corner guide socket assemblies shall be stainless steel and shall be 0.625 inch in length.
  - 2.3 The 104 socket connector (C1S) shall be recessed and mounted on the right rear panel of the chassis.
  - 2.4 The connector block shall have an insulation resistance of 5000 megohms. Contacts shall be secured in the blocks with stainless steel springs.
3. All MODEM and ACIA connections into and out of the controller unit shall be made through Connector C2 and Terminal Block T1.
  - 3.1 Terminal Block T1 shall be a one-position ten-pole terminal block. The terminal block shall be barrier type with 6-32, x 1/4-inch or longer, nickel plated brass binder head screws. Terminals shall be permanently identified as to their function.
  - 3.2 Connector C2 shall be a 14-contact socket block attached to the back plane of the controller unit. Locking catches shall be provided. Socket contact assignments shall be as shown on the plans.

CHAPTER 3  
SPECIFICATIONS FOR MONITOR UNIT  
MODEL 210

This Chapter defines the specifications applicable to the Model 210 monitor unit. These specifications shall supplement the General Specifications for Traffic Control Equipment and in case of conflict the specifications of this Chapter shall govern.

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## SECTION I

### GENERAL DESCRIPTION

1. The Model 210 monitor unit is a self-contained compact device which shall be capable of detecting conflicting signal indications. The method of conflict monitoring shall be based upon a design that shall render a reliable detection when one or more of the following are sensed:
  - a. conflicting field output voltages
  - b. threshold power supply voltage below specified
  - c. a watchdog timer error.
2. The Model 210 monitor unit shall be capable of monitoring sixteen field signal output circuits at the field terminals.



## SECTION II

### FUNCTIONAL REQUIREMENTS

1. All monitored field output alternating current voltages shall be measured as either average responding or true RMS responsive to both positive and negative halves of the sine wave.
2. The conflict monitoring circuitry shall sense voltages greater than 25 volts alternating current with a duration of 500 milliseconds or longer. The conflict monitoring circuitry shall not sense voltages less than 15 volts alternating current or any voltage having a duration of less than 200 milliseconds.
3. The conflict monitoring circuitry may or may not detect a conflict when the voltage is greater than 15 volts but less than 25 volts and the duration is greater than 200 milliseconds but less than 500 milliseconds.
4. The conflict monitoring circuitry shall be capable of detecting both a positive and negative half-wave failure under the foregoing conditions.
5. The monitor unit shall trigger when the watchdog circuit has failed to receive a change in state from the controller unit for 1 second  $\pm 10$  percent. The controller unit will change its output to the watchdog timer once every 100 milliseconds.
6. The monitor unit shall sense the cabinet power supply +24 VDC. It shall consider voltages as low as 22 VDC acceptable, but voltages below 18 VDC shall trigger the monitor. Voltages between +22 VDC and +18 VDC may or may not trigger the monitor. Voltages below monitor thresholds with a duration less than 200 milliseconds shall not trigger the monitor.
7. When the monitor unit is triggered, the following sequence of events shall occur:
  - 7.1 An output contact shall close. This shall cause an automatic switching of the field signals from normal operation to flashing operation.

A power failure shall not result in resetting the monitor unit. The monitor unit upon detection of a conflict shall remain triggered until reset by a front panel control. The output relay shall be electro-mechanical.

- 7.1.1 The output relay contacts shall be rated for a minimum of 3 amperes at 120 VAC. The output shall be electrically isolated from ground with a rating of 2000 VDC or better, and 1000 million ohms. Opening and closing time of the contacts shall not exceed 30 milliseconds.
- 7.1.2 The stop timing output shall be an NPN open collector which, when triggered, shall be capable of sinking 50 milli-amperes at 30 volts. This output shall be compatible with the appropriate input in the Controller Unit. The output shall have a blocking diode installed to prevent it from sourcing power into the controller unit input.
- 7.2 The monitor shall store and display the conflicting indications existing at the moment of conflict. These indications, 16 indicators, shall be mounted on the front panel. The monitor shall retain this display until reset by a front panel push-button, or upon the loss of power.
- 7.3 When the monitor is triggered as a result of sensing a watchdog timing error, it shall illuminate a front panel indicator light labeled "Watchdog Error". The monitor shall retain this condition until reset by a front panel push-button or the loss of power. An internal watchdog muzzle switch shall be provided to inhibit triggering of monitor due to watchdog timer. Power failures of duration of 50 milliseconds or greater shall not cause the timer to trip.
- 7.4 When the monitor unit is triggered as the result of sensing a voltage error, it shall extinguish a front panel indicator light labeled "Power". The "Power" indicator light shall remain extinguished until the +24 DC supply is restored.
- 8. The monitor module shall be equipped with a programming card. The programming card shall be a printed circuit board 1/16 inch thick and shall plug into the module through a slot in the front panel. A programming card shall be supplied with a full complement of diodes #IN4148, or equivalent. Each programming card shall contain 120 diodes. The programming card shall be logically labeled and laid out for easy identification of the diodes by switch pack.

All switch pack signals being monitored shall be in conflict with all other switch pack signals being monitored, unless a diode (anode to numerical pins and cathode to alphabetical pins) has been removed. Removal of a diode shall define a non-conflict. Example: a diode removed from between Pins 4 and B indicates the signals from Switch Pack 5 are not in conflict with the signals from Switch Pack 2. In addition, the yellow signals from all switch packs shall be monitored unless a jumper is placed between the appropriate yellow switch pack pin and yellow inhibit common on the programming card. Green and yellow output signals from the switch packs shall be "OR'd " together.

- 8.1 The programming card shall be 6 inches in depth and 5.15 inches to 5.30 inches in height, and shall intermate with a 28/56 pin double sided connector having bifurcated contacts on 0.156-inch centers. The printed circuit board shall bisect its edge board fingers at their centers to within  $\pm 0.016$  inch. The center of the edge board fingers shall be 2.6375 inches from either edge of the board. This card when installed shall be provided with card ejectors (Stanford Applied Engineering type 6100 or equivalent) for removal from the front panel. This programming card shall be flush with the front panel and slide smoothly on its tracks while being inserted into or removed from the monitor module.

#### 7.1.1 Programming Card Connector Wiring

<u>PIN</u>	<u>FUNCTION (Circuit Side)</u>	<u>PIN</u>	<u>FUNCTION (Component Side)</u>
1	Channel #2 Green	A	Channel #1 Green
2	Channel #3 Green	B	Channel #2 Green
3	Channel #4 Green	C	Channel #3 Green
4	Channel #5 Green	D	Channel #4 Green
5	Channel #6 Green	E	Channel #5 Green
6	Channel #7 Green	F	Channel #6 Green
7	Channel #8 Green	H	Channel #7 Green
8	Channel #9 Green	J	Channel #8 Green

9 Channel #10 Green	K Channel #9 Green
10 Channel #11 Green	L Channel #10 Green
11 Channel #12 Green	M Channel #11 Green
12 Channel #13 Green	N Channel #12 Green
13 Channel #14 Green	P Channel #13 Green
14 Channel #15 Green	R Channel #14 Green
15 Channel #16 Green	S Channel #15 Green
16 DCGROUND	T CONFLICT
17 Channel #1 Yellow	U Channel #9 Yellow
18 Channel #2 Yellow	V Channel #10 Yellow
19 Channel #3 Yellow	W Channel #11 Yellow
20 Channel #4 Yellow	X Channel #12 Yellow
21 Channel #5 Yellow	Y Channel #13 Yellow
22 Channel #6 Yellow	Z Channel #14 Yellow
23 Channel #7 Yellow	AA Channel #15 Yellow
24 Channel #8 Yellow	BB Channel #16 Yellow
—	—
25 N.C.	CC N.C.
26 N.C.	DD N.C.
27 N.C.	EE N.C.
28 Yellow Inhibit Common	FF N.C.

— Mating connector shall be keyed between pins 24 and 25 and also between BB and CC.

- 8.1.2 Pin T of the program card called "CONFLICT" shall cause the monitor to trigger when permitted to float, and be inhibited when grounded to Pin 16. All program cards shall have a jumper between Pins 16 and T.
- 9. The monitor, when connected to the switch pack output circuit, shall provide protection against conflicting signals resulting from controller unit failure, switch pack failure, short circuited field wiring, etc.

### SECTION III

#### ELECTRICAL REQUIREMENTS

1. The front panel shall be wired to earth ground.
2. The conflict monitor shall not trigger when sensing radio frequency energy with a frequency of 10 MegaHertz or greater and an average power of 100 milliWatts or less.

## SECTION IV

### MECHANICAL REQUIREMENTS

1. The dimensions of the monitor module shall be as shown on the plans.
2. A handle shall be attached to the front panel, and shall protrude no further than 1-1/4 inches from the face of the front panel.
3. The overall dimensions of the monitor module shall be between 9.75 inches and 9.85 inches from the face of the front panel to the panel surface holding the front mating connector. The module shall be no wider than 1.38 inches. The printed circuit card shall be 1/16 inch thick. The module shall intermate with a 28/56 pin double-sided connector having bifurcated contacts on 0.156-inch centers. The printed circuit board connector shall bisect its edge board fingers at their centers to within  $\pm 1/64$  of an inch. The center of the edge board fingers shall be 4.65 inches from either edge of the board. The center line of the 1/16-inch printed circuit card shall be 0.20-inch ( $\pm 1/64$ -inch) from the left edge of the front panel (Front View).

## SECTION V

### CONNECTOR REQUIREMENTS

1. All electrical connections into or out of the monitor module shall be through a printed circuit connector, having two rows of 28/56 inch independent bifurcated contacts on 0.156-inch centers, and shall intermate with that portion of the printed circuit card which is 4.5 inches wide.



Monitor Unit Connector Wiring Assignment - Signal Input/Output  
Connector

<u>PIN</u>	<u>FUNCTION</u>	<u>LEVEL TO OPERATE</u>	<u>VOLTAGE</u>		<u>CURRENT MAX</u>
			<u>MAX</u>	<u>MIN</u>	
1	Channel 2 Green	120VAC	135VAC	25VAC	15MA
2	Channel 13 Green	120VAC	135VAC	25VAC	15MA
3	Channel 6 Yellow	120VAC	135VAC	25VAC	15MA
4	Channel 4 Green	120VAC	135VAC	25VAC	15MA
5	Channel 14 Green	120VAC	135VAC	25VAC	15MA
6	Channel 8 Yellow	120VAC	135VAC	25VAC	15MA
7	Channel 5 Green	120VAC	135VAC	25VAC	15MA
8	Channel 13 Yellow	120VAC	135VAC	25VAC	15MA
9	Channel 1 Yellow	120VAC	135VAC	25VAC	15MA
10	Channel 7 Green	120VAC	135VAC	25VAC	15MA
11	Channel 14 Yellow	120VAC	135VAC	25VAC	15MA
12	Channel 3 Yellow	120VAC	135VAC	25VAC	15MA
13	Channel 9 Green	120VAC	135VAC	25VAC	15MA
14	Not Assigned				
15	Channel 11 Yellow	120VAC	135VAC	25VAC	15MA
16	Channel 9 Yellow	120VAC	135VAC	25VAC	15MA
17	Not Assigned				
18	Channel 12 Yellow	120VAC-	135VAC	25VAC	15MA
19	Not Assigned				
20	Chassis Ground				
21	AC				
22	Watchdog Timer	DC Ground			
23	+24V DC	+24V DC	+26V DC	+22V DC	
24	Pins 24 and 25 Tied Together				
25					
26	Not Assigned				
27	Not Assigned				
28	Output SW, Side #1				
—	Slotted for Keying				

Note: Pins 24 and AA are shorted. Maximum current  
requirement shall be 500 MA

Monitor Unit Connector Wiring Assignment - Signal Input/Output  
Connector

<u>PIN</u>	<u>FUNCTION</u>	<u>LEVEL TO OPERATE</u>	<u>VOLTAGE</u>		<u>CURRENT MAX</u>
			<u>MAX</u>	<u>MIN</u>	
A	Channel 2 Yellow	120VAC	135VAC	25VAC	15MA
B	Channel 6 Green	120VAC	135VAC	25VAC	15MA
C	Channel 15 Green	120VAC	135VAC	25VAC	15MA
D	Channel 4 Yellow	120VAC	135VAC	25VAC	15MA
E	Channel 8 Green	120VAC	135VAC	25VAC	15MA
F	Channel 16 Green	120VAC	135VAC	25VAC	15MA
H	Channel 5 Yellow	120VAC	135VAC	25VAC	15MA
J	Channel 1 Green	120VAC	135VAC	25VAC	15MA
K	Channel 15 Yellow	120VAC	135VAC	25VAC	15MA
L	Channel 7 Yellow	120VAC	135VAC	25VAC	15MA
M	Channel 3 Green	120VAC	135VAC	25VAC	15MA
N	Channel 16 Yellow	120VAC	135VAC	25VAC	15MA
P	Not Assigned				
R	Channel 10 Green	120VAC	135VAC	25VAC	15MA
S	Channel 11 Green	120VAC	135VAC	25VAC	15MA
T	Not Assigned				
U	Channel 10 Yellow	120VAC	135VAC	25VAC	15MA
V	Channel 12 Green	120VAC	135VAC	25VAC	15MA
W	Not Assigned				
X	Not Assigned				
Y	DC Ground	DC Ground			
Z	External Reset	DC Ground			
AA	+24VDC	+24VDC	+26VDC	+22VDC	500MA
BB	Stop Time	DC Ground			
CC	Not Assigned				
DD	Not Assigned				
EE	Output SW, Side #2				
FF	AC+	120VAC	135VAC	95VAC	
—	Slotted for Keying				

## CHAPTER 4

### SPECIFICATIONS FOR TWO-CHANNEL LOOP DETECTOR SENSOR UNIT, MODEL 222

### SPECIFICATIONS FOR FOUR-CHANNEL LOOP DETECTOR SENSOR UNIT, MODEL 224

This Chapter defines the specifications applicable to the Model 222 Two-Channel Loop Detector Sensor Unit and the Model 224 Four-Channel Loop Detector Sensor Unit. These specifications shall supplement the General Specifications for Traffic Control Equipment and in case of conflict the specifications of this Chapter shall govern.

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SPECIFICATIONS FOR  
TWO-CHANNEL AND FOUR-CHANNEL LOOP DETECTOR SENSOR UNITS

SECTION I

GENERAL DESCRIPTION

1. The two-channel and four-channel loop detector sensor units contain two and four detector channels, respectively. The modules shall be compatible with and intermate to the standard input files. The detector channels working independently, will produce output signals when vehicles pass over or remain within wire loops embedded in the roadway.

The detector units shall be solid state design. The method of detection shall be based upon a design that shall render detection when a conductive metallic mass entering a loop causes a change of 0.01 percent in detector input inductance.

## SECTION II

### FUNCTIONAL REQUIREMENTS

#### 1. Operational Specifications

- 1.1 Each detector channel shall be capable of detecting all types of licensed motor vehicles at a distance of up to 800 feet from the loop to the detector sensor unit.
- 1.2 The detector sensor unit shall be mounted on a edge-connected, printed circuit board.
  - 1.2.1 The 4-channel detector unit shall occupy the space of two 2-channel detector units.
- 1.3 Each detector channel shall not draw more than 100 milliamperes from the +24 volt DC cabinet power supply for its operating power.
- 1.4 The detector module front panel shall be provided with a hand pull to facilitate insertion and removal from the input file.
- 1.5 Each detector channel shall have a front panel-mounted indicator to provide visual indication of each vehicle detection.
- 1.6 Detector tuning shall be automatic or manual. Only front panel controls shall be used in the manual turning operation.
- 1.7 The detectors shall comply with all performance requirements herein specified when connected to an inductance (loop plus lead-in) of from 50 to 500 microhenries with a Q-parameter as low as 5 at the detector operating frequency.
- 1.8 Each detector channel output shall be an opto-isolated NPN open collector capable of sinking 50 milliamperes at 30 volts. This output shall be compatible with the controller unit inputs.
- 1.9 Each sensor unit shall intermate with and operate in a Standard Input File.
- 1.10 A switch position shall be provided to disable the output of each channel on an individual basis.

1.11 Loop inputs to each channel shall be transformer isolated.

## 2. Tuning

The vehicle detector circuits shall be designed so that drift which occurs with regard to the environment and applied power shall not cause in actuation.

## 3. Mode Selection Requirements

3.1 Each detector channel shall have two selectable modes of detection - Pulse and Presence.

### 3.2 Pulse Mode

3.2.1 In the pulse mode, each new vehicle presence within the zone of the detection shall initiate a detector channel output pulse of  $125 \pm 25$  milliseconds in duration.

3.2.2 Should a vehicle remain in a portion of the zone of detection for a period in excess of two seconds, the detector channel shall automatically "tune out" the presence of said vehicle. The channel shall then be capable of detecting another vehicle entering the same zone of detection. The recovery time between the first vehicle pulse and channel capability to detect another vehicle shall be three seconds maximum.

### 3.3 Presence Mode

3.3.1 In the presence mode, the detector channel shall recover to normal sensitivity within one second after termination of vehicle presence in the zone of detection regardless of the duration of the presence.

3.3.2 With the detector channel in its most sensitive setting, the presence of a vehicle in the zone of detection shall be detected a minimum of 3 minutes for a vehicle causing 0.01 percent inductance change and a minimum of 10 minutes for a vehicle causing 0.60 percent inductance change.

- 3.3.3 The lowest sensitivity setting in the presence mode is designated as the "Occupancy" (OCC) setting. With the detector channel in the OCC setting, the presence of a vehicle causing a one percent, or greater, change of inductance shall be detected for a minimum of 4 minutes.

#### 4.0 Sensitivity

- 4.1 Each detector channel shall be equipped with panel selectable sensitivity setting(s) in both presence and pulse modes to accomplish the following under operational and environmental requirements of this specification:
- 4.1.1 Each detector channel shall respond to an inductance change of 0.02 percent while connected to the following three turn loop configurations.
- (1) Single 6' by 6' loop with a 50-foot lead-in cable.
  - (2) Single 6' by 6' loop with a 800-foot lead-in cable.
  - (3) Four 6' by 6' loops connected in series/parallel with a 250-foot lead-in cable.
  - (4) Four 6' by 6' loops connected in series with a 800-foot lead-in cable.
- 4.1.2 Each detector channel shall respond to Occupancy (OCC) setting(s) to a nominal change in inductance between 0.15 percent to 0.4 percent while connected to the above loop configurations. This setting shall not respond to an inductance change of less than 0.1 percent.
- 4.2 The detector channel shall not detect vehicles, moving or stopped, at distances of 3 feet or more from any loop perimeter.
- 4.3 All sensitivity settings shall not differ more than  $\pm 40$  percent from the nominal value chosen.

## 5. Response timing

- 5.1 Response time of the detector channel for the OCC setting shall be less than 20 milliseconds. That is, for any negative inductive change which exceeds its sensitivity threshold, the channel shall output a ground true logic level within 20 milliseconds. When such change is removed, the output shall become an open circuit within 20 milliseconds. For test purposes, the negative change of inductance will be maintained for a minimum of 100 milliseconds and a maximum of 600 milliseconds after it is applied. When the difference between the length of time the inductance change is applied, and the corresponding ground true output time are averaged over ten trials, the value that average difference shall not exceed 10 milliseconds.
- 5.2 The response time of the detector channel for the most sensitive setting shall be less than 250 milliseconds for a 1.0 percent inductance change.



## SECTION III

### ELECTRICAL REQUIREMENTS

#### 1. Application of power

- 1.1 The detector channels shall begin normal operation within thirty seconds after the application of power or the reset signal.

#### 2. Interference

- 2.1 The separate channels contained within a given unit shall include means to prevent cross-talk with one another.
- 2.2 Each unit shall include means to prevent cross-talk with other modules. If the prevention means is manual, the control for it shall be located on the front panel of the unit. No additional external wiring shall be required to implement the prevention means.

#### 4. Lightning protection

- 4.1 Lightning protection shall be installed within the detector unit.
  - 4.1.1 The protection shall enable the detector to withstand the discharge of a 10 microfarad capacitor charged to +1000 volts directly across the detector input pins with no loop load present.
  - 4.1.2 The protection shall enable the detector to withstand the discharge of a 10 microfarad capacitor charged to +2000 volts directly across either the detector input inductance pins or from either side of the detector input inductance pins to earth ground. The detector chassis shall be grounded and the detector input pins shall have a dummy resistive load attached equal to 5.0 ohms.

## 5. Tracking Rate

- 5.1 The detector shall be capable of compensating or tracking for an environmental change up to 0.001 percent change in inductance per second. This requirement shall be met within two hours after initial application of operating power.

## 6. Tracking Range

- 6.1 The detector shall be capable of normal operation as the input inductance is changed plus or minus ( $\pm$ ) 5.0 percent from the quiescent tuning point regardless of internal circuit drift.
- 6.2 The detector shall be capable of normal operation as the input resistance is changed plus or minus ( $\pm$ ) 0.5 percent from the quiescent tuning point regardless of internal circuit drift.

## 7. Temperature Change

- 7.1 The operation of the detector unit shall not be affected by changes in the inductance of the loop caused by environmental changes with the rate of temperature change not exceeding 1° C per three minutes. The opening or closing of the controller cabinet door with a differential temperature of 18° C between the inside and outside shall not affect the proper operation of the detector.

## 8. Board Edge Connector Pin Assignment

<u>Pin</u>	<u>Function</u>	<u>Pin</u>	<u>Function</u>	<u>Pin</u>	<u>Function</u>
A	DC Ground	J	Loop #2 Input	S	Loop #3 Output (C)
B	+24 VDC	K	Loop #2 Input	T	Loop #3 Output (E)
C	Detector Reset	L	Chassis Ground	U	Loop #4 Input
D	Loop #1 Input	M	AC-	V	Loop #4 Input
E	Loop #1 Input	N	AC+	W	Loop #2 Output (C)
F	Loop #1 Output (C)	P	Loop #3 Input	X	Loop #2 Output (E)
H	Loop #1 Output (E)	R	Loop #3 Input	Y	Loop #4 Output (C)
				Z	Loop #4 Output (E)

Slotted for keying

(C) Collector

(E) Emitter

## 9. Reset

- 9.1 The detector unit shall respond to a ground reset signal of 15 microseconds and begin normal operation within 30 seconds after the reset command.

## CHAPTER 5

### SPECIFICATIONS FOR MAGNETIC DETECTOR SENSING ELEMENT, MODEL 231

### SPECIFICATIONS FOR TWO-CHANNEL MAGNETIC DETECTOR AMPLIFIER, MODEL 232

### SPECIFICATIONS FOR FOUR-CHANNEL MAGNETIC DETECTOR AMPLIFIER, MODEL 234

This Chapter defines the specifications applicable to the Model 231 magnetic detector sensor element, the Model 232 two-channel magnetic detector amplifier and the Model 234 four-channel magnetic detector amplifier. These specifications shall supplement the General Specifications for Traffic Control Equipment and in case of conflict the specifications of this Chapter shall govern.

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SPECIFICATIONS FOR  
TWO-CHANNEL AND FOUR-CHANNEL  
MAGNETIC DETECTOR AMPLIFIERS

SECTION I

GENERAL DESCRIPTION

1. The two and four channel magnetic detector amplifiers are units containing two or four magnetic detector channels, respectively. Each independent detector channel working with its associated magnetic detector sensing element shall produce an output signal when vehicles pass over the magnetic detector sensing element embedded in the roadway.

The magnetic detector amplifier shall be of solid state design. The method of detection shall be based upon a design that shall render reliable detection when a voltage is induced in the sensing element by a passing vehicle.

## SECTION II

### FUNCTIONAL REQUIREMENTS

1. Magnetic detector amplifier requirements (Models 232 and 234)
  - 1.1 The magnetic detector amplifier shall be mounted on an edge-connected printed circuit board.
    - 1.1.1 The four channel magnetic detector amplifier shall occupy the front panel space of two 2-channel magnetic detector amplifiers.
  - 1.2 Each magnetic detector channel shall not draw more than 60 milliamperes from the +24 volt DC cabinet power supply for its operating power.
  - 1.3 The detector amplifier front panel shall be provided with a hand pull to facilitate insertion and removal from the Input File.
  - 1.4 Each detector channel shall have a front panel mounted indicator to provide visual indication of each vehicle detection.
  - 1.5 All controls required for tuning, including sensitivity shall be readily adjustable without use of tools and shall be mounted on the front panel.
  - 1.6 When connected to a Model 231 magnetic detector sensing element with 1000 feet of lead-in cable the amplifier shall detect a Honda 100 motorcycle passing within 18 inches of the sensing element installed 12 inches below the top of the pavement at all speeds between 3 and 80 miles per hour.
  - 1.7 Each detector channel output shall be an opto-isolated NPN open collector capable of sinking 50 milliamperes at 30 volts. The output shall be compatible with the inputs for the Model 170 Controller Unit. The output shall indicate the passage of a vehicle by saturating the NPN transistor or optical isolator, with no more than 0.6 volt DC across the output circuit. Detector channel output shall be 100 milliseconds minimum in duration.

- 1.8 A switch or switch position shall be provided to disable the output of each channel on an individual basis.
- 1.9 A momentary switch or switch position shall be provided to place a call on each channel on an individual basis.
- 1.10 Each amplifier shall intermate with and operate in a Standard Input File.

### SECTION III

#### CONNECTOR REQUIREMENTS

1. The Printed Circuit Board Edge Connector shall intermate with the Cabinet Input Files.
2. Connector Pin Assignments are as follows:

<u>PIN</u>	<u>FUNCTION</u>	<u>PIN</u>	<u>FUNCTION</u>
A	DC Ground	N	AC+
C	Not Connected	R	Detector #3 Element
D	Detector #1 Element	S	Detector #3 Output (C)
E	Detector #1 Element	T	Detector #3 Output (E)
F	Detector #1 Output (C)	U	Detector #4 Element
H	Detector #1 Output (E)	V	Detector #4 Element
J	Detector #2 Element	W	Detector #2 Output (C)
K	Detector #2 Element	X	Detector #2 Output (E)
L	Chassis Ground	Y	Detector #4 Output (C)
<u>M</u>	AC-	Z	Detector #4 Output (E)

         Slotted for keying  
(C) - Collector  
(E) - Emitter

## 2. Magnetic Detector Sensing Element (Model 231)

- 2.2 The case of the sensing element shall be constructed of nonferrous material suitable for use in the environment in which it will operate and shall be sealed to prevent the entrance of moisture. No moving parts or active components shall be contained in the element.
- 2.3 Each sensing element shall be designed for ease of installation, repositioning, and removal. It shall be no larger than 2-1/4 inches in diameter and shall have no sharp edges along its length. The overall length shall not exceed 21 inches.
- 2.4 Each sensing element shall be provided with a minimum of 75 feet of lead-in cable.
- 2.5 The passage of a Honda 100 motorcycle within 18 inches of the sensing element, at speeds from 3 to 80 miles per hour, shall provide sufficient signal to operate a Model 232 amplifier with 1000 feet of lead-in cable between the amplifier and the sensing element.



## CHAPTER 6

### SPECIFICATIONS FOR TWO-CHANNEL MAGNETOMETER DETECTOR CONTROL UNIT, MODEL 228

### SPECIFICATIONS FOR MAGNETOMETER SENSING ELEMENT, MODEL 227

This Chapter defines the specifications applicable to the Model 228 two-channel magnetometer detector control unit and the Model 227 magnetometer sensing element. These specifications shall supplement the General Specifications for Traffic Control Equipment and in the event of conflict the specification of this Chapter shall govern.

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SPECIFICATIONS FOR TWO-CHANNEL MAGNETOMETER  
DETECTOR CONTROL UNITS, MODEL 228

SECTION I

GENERAL DESCRIPTION

- 1.1 The two-channel magnetometer detector control units are units which plug into the cabinet Input File. Each independent detector channel shall produce an output signal when vehicles pass over the magnetometer sensing element embedded in the roadway.
- 1.2 The detector control units shall be of solid-state design. The method of detection shall be based upon sensing a change in the vertical component of the earth's magnetic field caused by the passage or presence of a vehicle over the detector sensing element.
- 1.3 A minimum of two modes of operation shall be available as follows:
  - 1.3.1 Pulse Mode. The pulse mode of operation shall provide an output closure of  $125 \pm 25$  milliseconds duration for each vehicle entering the area of detection.
  - 1.3.2 Presence Mode. The presence mode of operation shall indicate continually the presence of a vehicle until the vehicle leaves the area of detection, whereupon the indication shall cease within 100 milliseconds.

## SECTION II

### FUNCTIONAL REQUIREMENTS

- 1.1 The magnetometer detector control unit shall be mounted on an edge-connected printed circuit board.
- 1.2 Each control unit shall house two complete, fully independent detection channels. Each channel shall operate with one to six sensing elements connected to it, and shall provide a separate output closure.
- 1.3 Each channel shall detect and provide an output closure to indicate the presence or passage of vehicles in lanes equipped with sensing elements at any speed from 0 to 80 miles per hour.
- 1.4 Parked or stalled vehicles over probes of one channel shall have no effect on the operation of any other channel.
- 1.5 Each detector channel output shall be an opto-isolated NPN open collector capable of sinking 50 milliamperes at 30 volts. This output shall be compatible with the controller unit inputs.
- 1.6 Damage to sensing elements or cables of one channel shall not affect operation of any other channel.
- 1.7 The detector shall operate at any distance up to 3000 feet between the control unit and the sensing elements.
- 1.8 Following a power interruption, the control unit shall return to normal operation within three minutes.
- 1.9 The front panel of the control unit shall contain:
  - (a) the light or meter to indicate detection of a vehicle,
  - (b) the overcurrent protection,
  - (c) switch for selecting the mode of operation,
  - (d) controls for calibrating the detector,

- (e) a hand pull to facilitate insertion and removal from the Input File,
  - (f) a switch or control shall be provided to disable the output of each channel on an individual basis. A switch or switch position shall be provided to place a call on each channel on an individual basis.
- 1.10 All switches and controls shall be clearly and permanently identified and shall be operable without the use of tools or external meters.
  - 1.11 Each control unit shall intermate with and operate in a Standard Input File.
  - 1.12 Each control channel shall not draw more than 120 milliamperes from the +24 volt DC supply.
  - 1.13 The printed circuit board shall be 4.5 inches by 6.5 inches. The width of the front panel shall be 2.3 inches.
  - 1.14 The magnetometer detector module shall detect vehicles as required in this section when connected to the magnetometer sensing element, Model 227. A California Standard magnetometer sensing element, manufactured by Canoga Controls, Inc., is available for inspection at the Transportation Laboratory at 5900 Folsom Boulevard, Sacramento.
  - 1.15 Each detector channel output shall be an opto-isolated NPN open collector capable of sinking 50 milliamperes at 30 volts. The output shall be compatible with the inputs for the Model 170 Controller Unit.

## CONNECTOR REQUIREMENTS

1. The printed circuit board edge connector shall intermate with the 22-pin double-sided connector in the standard Input File.
2. The connector pin assignments are as follows:

<u>Pin</u>	<u>Function</u>	<u>Pin</u>	<u>Function</u>
A	DC Ground	N	AC+
<u>B</u>	+24DC		
<u>C</u>	Reset	P	Sensing Element #2
D	Sensing Element #1 Input	R	Sensing Element #2
E	Sensing Element #1 Input	S	Control Unit Output #2 (Collector)
F	Control Unit Output #1 (Collector)	T	Control Unit Output #2 (Emitter)
H	Control Unit Output #1 (Emitter)	U	Sensing Element #2 Excitation
J	Sensing Element #1 Excitation	V	Sensing Element #2 Excitation
K	Sensing Element #1 Excitation	W	NA
L	Equipment Ground	X	NA
<u>M</u>	AC-	Y	NA
		Z	NA

— Slotted for keying (Between Pins B & C and Pins M & N)

## SECTION IV

### MAGNETOMETER DETECTOR SENSING ELEMENTS (Model 227)

1. Each magnetometer detector sensing element shall be designed to be compatible with the Magnetometer Detector Module, Model 228.
2. The sensing element shall be cylindrical in shape, shall be no larger than 2 inches in diameter or more than 4.25 inches in length and shall contain no moving parts.
3. The sensing element shall have a non-ferrous, moisture-proof housing, shall not be affected by extremes of temperature or humidity, shall be capable of withstanding all types of soil conditions and shall be sealed to prevent the entrance of moisture.
4. The connecting cable attached to each sensing element shall be suitable for both direct burial in earth and installation in conduit, and shall be 50 feet in length, minimum.

## CHAPTER 7

### SPECIFICATIONS FOR TWO-CHANNEL ISOLATOR, MODEL 242

### SPECIFICATIONS FOR FOUR-CHANNEL ISOLATOR, MODEL 244

This Chapter defines the specifications applicable to the Model 242 two channel isolator and the Model 244 four channel isolator. These specifications shall supplement the General Specifications for Traffic Control Equipment, and in the event of conflict the specification of this Chapter shall govern.

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SPECIFICATIONS FOR  
TWO CHANNEL AND FOUR CHANNEL ISOLATORS

SECTION I

GENERAL DESCRIPTION

1. The 2-channel and 4-channel isolators are units, containing two or four isolation channels respectively, which plug into the Standard Input File. Each isolation channel, shall be independent and shall provide isolation between electrical contacts external to the module (pedestrian push buttons, preemption, etc.) and the controller unit input.

The isolators shall be of solid state design. The method of isolation shall be based upon a design which shall provide reliable operation.



## SECTION II

### FUNCTIONAL REQUIREMENTS

#### 1. Operational Specifications

- 1.1 The isolator shall be mounted on an edge-connected printed circuit board.
  - 1.1.1 The 4-channel isolator shall occupy the space of two 2-channel isolators.
- 1.2 The isolator shall have an internal power supply which shall supply  $\pm 20 \pm 4$  Volts DC to the field input side of the isolation channels. The Model 242 Isolator shall not draw more than 2.5 watts of power and the Model 244 more than 5 watts.
- 1.3 The isolator front panel shall be provided with a hand-pull to facilitate insertion and removal from the input file enclosure.
- 1.4 Each isolation channel shall have a front panel-mounted indicator to provide visual indication of each electrical contact closure and test switch to place an input to the isolation channel. Both indicator and switch shall be on the field input side of the isolator. Test switch shall be a single pole-double throw, three-position switch; momentary ON, OFF and maintained ON positions. The contacts shall be either silver or coin silver with gold over nickel plate rated for 5 amperes at 120 Volts AC.
- 1.5 Each isolation channel output shall be an opto-isolated NPN open collector capable of sinking 50 milliamperes at 30 volts. This output shall be compatible with the Model 170 Controller Unit. Each isolation channel shall present ground true logic to the controller unit inputs.
- 1.7 A field contact closure to the isolation channel shall cause a channel output of 100 milliseconds minimum duration. The contact closure input shall be 5 milliseconds minimum in duration before actuating the isolation channel output. The channel shall reset within 10 milliseconds after opening of either field contact or test switch.

## SECTION III

### ELECTRICAL REQUIREMENTS

#### 1. Electrical input interface

- 1.1 Each isolation channel field input shall be turned on (true) when a contact closure causes an input voltage of less than 8 volts DC, and shall be turned off (false) when the contact opening causes the input voltage to exceed 12 volts DC. Each input shall deliver no less than 15 nor more than 40 milliamperes to an electrical contact closure or short from the power supply.

#### 2. Isolation

- 2.1 The minimum isolation shall be 1000 megohms and 2,500 volts DC from input to output.

#### 3. Board Edge Connector Pin Assignment

<u>PIN</u>	<u>FUNCTION</u>	<u>PIN</u>	<u>FUNCTION</u>
A	DC Ground	M	AC-
B	+24 VDC	N	AC+
C	NA	P	Input #3
D	Input #1	R	Input Common
E	Input Common	S	Output #3 (C)
F	Output #1 (C)	T	Output #3 (E)
H	Output #1 (E)	U	Input Common
J	Input #2	V	Output #2 (C)
K	Input Common	W	Output #2 (E)
L	Chassis Gnd	X	Output #4 (C)
		Y	Output #4 (C)
		Z	Output #4 (E)

       Slotted for Keying  
(C) Collector  
(E) Emitter

#### 4. Lighting protection

- 4.1 Lightning protection shall be installed inside the Isolator.

- 4.1.1 The protection shall enable the isolator to withstand the discharge of a 10 microfarad capacitor charged to  $\pm 1000$  volts directly across the input pins with no load present.
- 4.1.2 The protection shall enable the isolator to withstand the discharge of a 10 microfarad capacitor charged to  $\pm 2000$  volts directly across either the input pins or from either side of the input pins to equipment ground. The input pins shall have a dummy resistive load attached equal to 5.0 ohms.

## CHAPTER 8

### SPECIFICATIONS FOR SWITCH PACK MODEL 200

This Chapter defines the specifications applicable to the Model 200 Switch pack. These specifications shall supplement the General Specifications for Traffic Control Equipment and in case of conflict the specification of this Chapter shall govern.

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SPECIFICATIONS FOR SWITCH PACK  
MODEL 200

SECTION I

SOLID STATE SWITCH PACK REQUIREMENTS

1. Each solid state switch pack shall be a modular assembly containing three solid state switches to be used for opening and closing connections between the applied power and the traffic signals.
2. The overall physical dimensions of the switch pack case shall be 7-3/8 inches  $\pm 1/8$  inch from the panel surface holding the plug connector to the front of the switch pack. The switch pack shall be no wider than 1.75 inches and no higher than 4.2 inches. The switch pack shall be provided with a connector Cinch-Jones Type #P2412-SB, or equivalent.
  - 2.1 A dust resistant, metal enclosure, suitably protected against corrosion, shall be provided to enclose all electrical parts of the switch pack.
3. The front panel of the switch pack shall be provided with three indicators to indicate the output of controller unit circuits "Red", "Yellow", and "Green". Indicators shall be labeled or color coded and mounted as follows: "Red" at top, "Yellow" in middle, and "Green" at bottom.
4. Switch pack control circuitry and switches shall be readily accessible by the use of a screwdriver or wrench.
5. Each switch pack shall be so constructed that persons inserting or removing the switch pack will not be exposed to any parts having live voltage, and will not be required to insert hands or fingers into the Cabinet Output File. A handle or gripping device shall be attached to the front of each switch pack.
6. The switch pack shall be so constructed that its lower surface will be no more than 2.100 inches below the centerline of the connector configuration and that no part will extend more than 0.900 inches to the left and 1.100 inches to the right of the centerline of the connector pin configuration.

7. Edge guides shall be provided on the switch pack.
8. During normal operation (no circuit or one circuit energized) the switch pack shall not use more than 20 milliamperes from a +24 volt DC source.
9. The switch pack shall not apply more than 30 volts, peak, to the signal input line, nor shall the input signal source be required to sink more than 20 milliamperes.

## SECTION II

### SOLID STATE SWITCHES

1. Three solid state switches shall be installed within each solid state switch pack. Each switch shall have the capability of switching any current from 0.05 to 10 amperes of tungsten lamp load at 120 volts, 60 Hertz, or 10 amperes at a power factor of 0.85 and a temperature of 70° C.
2. A low-level input, negative true logic, from the controller unit (saturated NPN transistor, 0 to +6.0 volts) shall cause the switch to be energized. A high-level input (cut-off NPN transistor, +16 volts or greater) shall cause the switch to deenergize. A transition zone from conducting to nonconducting (or vice versa) shall occur between 6 and 16 volts.
3. Each switch shall turn on within plus or minus five degrees of the zero voltage point of the AC sinusoidal line, and shall turn off within plus or minus five degrees of the zero current point of the alternating current sinusoidal line. The zero voltage turn on may be within plus or minus ten degrees of the zero voltage point only during the first half cycle of line voltage during which an input signal is applied.
4. Each switch shall be rated for a minimum of 30 million operations while switching a tungsten filament load of 1,000 watts.
5. Each switch shall have isolation between input DC control and AC to lights output circuit of 2,000 volts DC, or better, and 10,000 megohms DC.
6. The input circuit of each switch shall have reverse polarity protection.
7. Each switch shall have an OFF state dv/dt rating of 100 volts per microsecond.
8. The resistance between the AC+ input terminal and the AC+ output terminal of each switch shall be 15,000 ohms, minimum, when the switch is in the open position. The output current from the switch through the load when the load switch is in the OFF state shall not exceed 20 milliamperes peak.

9. Each switch shall have a one cycle surge rating of 175 amperes RMS and a one second surge rating of 40 amperes RMS.
10. Each switch shall be isolated so that line transients or switch failure will not adversely affect the controller unit.
11. Each switch shall be capable of withstanding a peak inverse voltage of 500 volts.
12. Solid state switches may utilize encapsulated components.



### SECTION III

#### CONNECTOR REQUIREMENTS

1. The connector and pin assignments shall be as shown on the plans.

## CHAPTER 9

### SPECIFICATIONS FOR FLASHER UNIT MODEL 204

This Chapter defines the specifications applicable to the Model 204 flasher unit. These specifications shall supplement the General Specifications for Traffic Control Equipment, and in case of conflict the specifications of this Chapter shall govern.

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## SPECIFICATIONS FOR FLASHER MODEL 204

### SECTION I

#### GENERAL DESCRIPTION

1. The Flasher Unit shall be a plug-in device containing a flasher control circuit and solid state switches. This unit will be used for alternate opening and closing connections between the applied power and the traffic signal lamps during flashing operation.

## SECTION II

### FUNCTIONAL REQUIREMENTS

1. The Model 204 shall have an internal power supply for logic and control.
2. The Flasher Unit shall commence flashing operation when AC power is applied to the input terminals.
3. The Flasher Unit shall provide fifty to sixty flashes per minute with a 50 percent duty cycle.
4. The interior of the Flasher Unit shall be readily accessible by the use of screw driver or wrench.

## SECTION IV

### MECHANICAL REQUIREMENTS

1. The dimensions of the Flasher Unit shall be the same as shown on the plans for Model 200 Switch Pack.
2. The Flasher Unit shall be constructed so that its lower surface will be 2.100 inches to 2.100  $\pm$ .05 inches below the centerline and so that no part will extend more than 0.850 inch to the left or more than 1.050 inches to the right of the centerline of the connector configuration.
3. When the Flasher Unit is in place, no electrically energized parts shall be exposed.
4. A handle or gripping device shall be provided on the front panel of the Flasher Unit.
5. Edge guides shall be provided on the Flasher Unit.

## SECTION V

### CONNECTOR REQUIREMENTS

1. All electrical connections into and out of the Flasher Unit shall be through a multi-terminal connector, Cinch-Jones Type #P-2406-SB or equal. The connector shall be rigidly fixed to the rear or base of the Flasher Unit.
2. The Flasher Unit shall intermate with a Beau Type #S5406 or equal connector as shown on the plans.

CHAPTER 10  
SPECIFICATIONS FOR CONTROLLER CABINET  
MODEL 330

NOTE: This specification is in final review and will be available at a later date

CHAPTER 11  
SPECIFICATIONS FOR CABINET  
MODEL 332

This Chapter defines the specifications applicable to the Model 332 Cabinet. These specifications shall supplement the General Specifications for Traffic Control Equipment and in case of conflict the specification of this Chapter shall govern.

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SPECIFICATIONS FOR CABINET  
MODEL 332

SECTION I

CABINET CONSTRUCTION

1. The cabinet shall be a rainproof cabinet with dimensions as shown on the Plans.
2. The cabinet and doors shall be fabricated from either 0.073-inch minimum thickness cold rolled sheet steel, or 0.125-inch minimum thickness sheet aluminum. All exterior seams for steel cabinet and doors shall be continuously welded.
  - 2.1 All exterior welds shall be ground smooth.
3. Cabinets shall be finished with a polymeric or an enamel coating system conforming to Color No. 14672 of Federal Standard 595a. All coatings shall be commercially smooth, substantially free of flow lines, paint washout, streaks, blisters, and other defects that would impair serviceability or detract from general appearance. The coatings shall comply with the following requirements:
  - 3.1 Coating Hardness -- the finish shall have a pencil lead hardness of HB minimum using an Eagle Turquoise pencil.
  - 3.2 Salt Spray Resistance -- The undercutting of the film of the coating system shall not exceed 1/8-inch average, from lines scored diagonally and deep enough to expose the base metal, after 350 hours exposure in a salt spray cabinet in accordance with ASTM Designation: B 117.

- 3.3 The cabinet shall suffer no coating loss when subjected to the following: Two test specimens, four inches by eight inches, of the same material and coating as the cabinet supplied, shall be furnished for the tests. Two 9-inch diagonal scratches exposing bare metal will be made on a specimen. It will be soaked in demineralized water for 192 hours. A one-inch wide strip of masking tape shall be tightly affixed to this surface and removed with one quick motion, evidence of blistering, softening, or peeling of the paint and/or coating from the base metal shall be cause for rejection.
- 3.4 Metal preparation shall be the 3-step Iron Phosphate Conversion Coating Bonderizing Technique.
- 3.5 The inside walls, doors and ceiling of the housing shall be painted the same as the outside finish.
4. The cabinet shall have single front and rear doors each equipped with a lock. When each door is closed and latched, the door shall be locked. The latching handles shall have provision for padlocking in the closed position. The lock shall be compatible with those in current use for traffic signal controller cabinets by the State. Two keys shall be furnished with each cabinet. The operating handle shall be cast aluminum or cadmium plated steel with 7.5-inch handle and 0.625-inch shank. The cabinet door frame shall be double-flanged out on all four sides and shall provide strikers to hold tension and form a firm seal between door gasketing and cabinet door frame.
5. The latching mechanism shall be a 3-point draw roller type. The center catch and pushrods shall be cadmium plated. Pushrods shall be turned edgewise at the outward supports and shall be 0.25 inch by 0.75 inch, minimum. Supports shall be 0.105-inch steel, minimum. Rollers shall have a minimum diameter of 0.875 inch and shall be equipped with ball bearings and nylon wheels. The center catch shall be fabricated of 0.1875-inch steel, minimum. Details of alternative designs shall be submitted for review and approval prior to the fabrication of the cabinets.

6. Each door's hinging shall be either a single continuous hinge or 4 butt hinges. Each hinge shall have a fixed pin. Front and rear doors shall be provided with catches to hold the door open at 90 degrees and 180 degrees, plus or minus ten degrees. The catches shall be 0.375-inch diameter minimum, cadmium plated steel rods. The catches shall be capable of holding the door open at 90° in a 60 mph wind at an angle perpendicular to the plane of the door.

Door hinges, pins, & bolts shall be made of stainless steel. The hinges shall be bolted to the cabinet. The hinge pins and bolts shall not be accessible to vandals.

7. The cabinet shall be provided with 2 lifting eyes to be used when placing the cabinet on the foundation. The lifting eyes shall be located as shown on the plans. Each eye shall have a minimum diameter of 3/4-inch and shall be capable of lifting 1000 pounds.
8. Each cabinet shall be provided with louvered vents in the front door with a removable and reuseable metal air filter 16 inches wide by 12 inches long by 0.875-inch deep. The filter shall cover the vents and shall be held firmly in place with bottom and side brackets and a spring-loaded upper clamp.

The bottom filter bracket shall be formed into a waterproof sump with drain holes to the outside. The louvered vents shall be designed and constructed such that a stream of water from a pressure head, such as a Rainbird sprinkler or other type sprinkler, will not enter the cabinet. The louvered area shall be less than or equal to the filtered area.

9. The police panel door shall be equipped with a lock keyed for a master police key. The police panel shall be mounted on the side of the cabinet as shown on the plans.

Two keys shall be furnished with each cabinet for the police lock. Each police key shall have a shaft at least 1-3/4 inches in length.

10. A standard EIA 19-inch rack shall be installed inside the cabinet for mounting the controller unit, input files, power supply, output file and power distribution assembly. The EIA rack shall consist of two pair of full length, continuous, adjustable equipment mounting angles of 0.1345-inch nominal thickness cadmium plated steel tapped with 10-32 threads with EIA universal spacing. The angles shall comply with Standard EIA RS-310-B.

Two cadmium plated controller unit supporting angles extending from the front to the back rails shall be supplied to support the controller unit. The angles shall be designed to support a minimum of 50 pounds each. The horizontal side of each angle shall be a minimum of three inches. The angles shall be mounted 17.5 inches from the top of the rack and shall be adjustable vertically.

11. Gasketing shall be provided on all door openings and shall be dust-tight. Gaskets shall be 0.25 min thickness closed cell neoprene and shall be permanently bonded to the metal. The mating surface of the gasketing shall be covered with a silicone lubricant to prevent sticking to the mating surface.
12. The cabinet base layout shall accommodate the anchor bolts and conduits as shown on the plans.

## SECTION II

### CABINET VENTILATION REQUIREMENTS

1. Each cabinet shall be equipped with an electric fan with ball or roller bearings and a capacity of at least 100 Cubic Feet of Air per Minute.
  - 1.1 The fan shall be mounted within the cabinet and vented out between the top of the cabinet and the front door as shown on the plans.
  - 1.2 The fan shall be thermostatically controlled and shall be manually adjustable to turn on between 33° C and 65° C with a differential of not more than 6° C between automatic turn on and turn off. The cabinet fan circuit shall be fused at 125 percent of the ampacity of the fan motor.
  - 1.3 Intake (including filter) and exhaust areas shall pass a minimum of 60 cubic feet of air per minute.

## SECTION III

### 1. CABINET ACCESSORIES

#### Power Supply

- 1.1 The power supply shall be provided in the cabinet to operate all equipment installed in the cabinet except the controller unit and the monitor unit.
- 1.2 The power supply shall utilize no more than 7 inches of rack height and a maximum depth of 6 inches from the front surface of the front rails.
- 1.3 The power supply shall be of ferro-resonant design having no active components and shall conform to the following requirements:
  - a. Line Regulation: Two percent from 95 to 135 VAC at 60 hertz, plus an additional 1.6 percent for each additional one percent frequency change.
  - b. Load Regulation: Five percent from 1 ampere to 5 amperes with a maximum temperature rise of 30° C above ambient.
  - c. Design Voltage: +24  $\pm$ 0.3 volts DC at 1/2 load and 40° C.
  - d. Full Load Current: Five amperes, minimum.
  - e. Ripple Noise: 2 volts peak-to-peak and 500 millivolts rms at full load.
  - f. Line Voltage: 95 to 135 VAC.
  - g. Efficiency: 60 percent, minimum.
  - h. Minimum Voltage: 22.8 VDC.
- 1.4 The power supply front panel shall include:
  - a. All fuses or circuit breakers
  - b. Pilot Lamp
  - c. Test points or meter for monitoring output voltage.
- 1.5 The power supply shall be enclosed to prevent accidental contact with energized parts.

## 2. Input File

- 2.1 Each input file shall utilize 5.25 inches of rack height. Each input file shall intermate with and support 14 two-channel loop detector units.
- 2.2 The input file shall provide card guides (top and bottom) and a 22-pin single-readout, edge-connector centered vertically for each detector. The input file shall allow air circulation through the top and bottom.
- 2.3 Pins D, E, J, & K on each edge connector shall be wired to the field terminals to provide for 2 loop detector channels or one magnetometer channel.
- 2.4 Loops #1 and #2 output collectors and emitters (pins F, H, W and X) for each slot shall terminate on a terminal block mounted on the rear of the input file and shall connect to the proper controller unit inputs in the Connector C1S wiring harness. Common grounding of output emitters will be permitted.
- 2.5 The input file shall be connected as shown on the plans.
- 2.6 The edge connectors shall be double sided connectors with the numbered side of each pin shorted to its respective lettered side internally.
- 2.7 A minimum of 1/2-inch clearance shall be maintained between the card guide and the face of the file.
- 2.8 The input file shall be provided with marker strips to identify items in the file. The marker strips shall be made of a material that can be easily and legibly written on using a pencil or ball point pen. Marker strips shall be located immediately below the item they are to identify.

### 3. Power Distribution Assembly

- 3.1 The power distribution assembly shall be furnished and mounted on the EIA 19-inch rack utilizing 7 inches of rack height. All equipment shall be readily accessible for ease of replacement. The depth of the assembly shall not exceed 10 inches from the front rails.

The power distribution assembly shall be provided with marker strips to identify Flasher Units in the assembly. The marker strip shall be of a material that can be easily and legibly written on using a pencil or ball point pen. Marker strips shall be located immediately below the Flasher Units they are to identify.

- 3.2 The following equipment shall be provided with the power distribution assembly:

2 - Equipment receptacles (one on the front panel, and another on the back panel readily accessible from back door)

1 - Controller unit receptacle

1 - Main Circuit Breaker

1 - Four-Pole Signal Bus Circuit Breaker

1 - Two-Pole Flash Bus Circuit Breaker

1 - Equipment Circuit Breaker

#### Terminal Blocks

2 - Mercury Contactor

1 - Auto/Flash Switch

1 - Flash Relay and Socket

2 - Flasher Socket

1 - Flash Indicator Light

- 3.3 The equipment receptacles, Flash Bus and Signal Bus circuit breakers shall be rated for 15 amperes at 120 volts AC.
- 3.4 The Main Circuit Breaker shall be rated for 50 amperes at 120 volts AC.
- 3.5 Equipment receptacles shall be NEMA 5-15R duplex type.
  - 3.5.1 The equipment receptacles shall have ground-fault circuit interruption as defined in the National Electrical Code. Circuit interruption shall occur on 6 milliamperes of ground-fault current and shall not occur on less than 4 milliamperes of ground-fault current.
- 3.6 An "Auto/Flash" switch shall be provided switch, when placed in "Flash" position (down) shall energize Mercury Contractor 2 (MC2) coil. When the switch is placed in the "Auto" position (up) the switch packs shall control the signal indications. The switch shall be a single pole, single throw toggle switch rated for 15 amperes at 120 volts AC.
- 3.7 A lamp labeled "Flash Operation" shall be provided on the front panel of the assembly. The lamp shall be driven by Flasher Unit Output through Transfer Relay Circuit #1.
- 3.8 The controller unit receptacle shall be a NEMA Type 5-15R mounted on the back panel of the assembly.
- 3.9 Terminal blocks shall be provided and mounted on the back panel of the assembly. The blocks shall be of type specified for signal field wire terminal blocks. Two spare positions shall be provided. All conductors from the power distribution assembly routed to the cabinet wiring shall be connected to the terminal block on a common side, except for the AC power conductor between the service terminal block and main circuit breaker. All internal conductors terminating at the blocks shall be connected to the other side of the blocks. Terminal position assignments shall be as shown on the plans.



- 3.10 The Flash Relays shall meet the requirements for Heavy Duty Relays.
- 3.11 A leakage resistor, which will permit a small amount of current to pass through the relay coil if the contacts should remain closed after the coil circuit is opened, shall be installed across the terminals of the relay socket to overcome the residual magnetism effects.

#### 4. Output File

- 4.1 Card guides shall be provided to support the switch packs and the monitor unit.
- 4.2 The output file shall utilize 10.5 inches of rack height and shall be capable of containing 12 switch packs, 4 flash transfer relays, and the monitor unit. Four flash transfer relays and one monitor unit shall be furnished with each output file.
- 4.3 The Output File shall be provided with marker strips to identify items in the file. The marker strips shall be made of a material that can be easily and legibly written on using a pencil or ball point pen. Marker strips shall be located immediately below the item they are to identify.
- 4.4 Switch pack, monitor unit and flash transfer relay sockets shall be accessible from the back of the file without the use of tools.
- 4.5 Field wire terminal blocks shall be mounted vertically on the back of the assembly. The 3 terminal blocks shall be the 12-position type.
- 4.6 The controller unit outputs to the Output File shall be connected through Connector C4.
- 4.7 The red and yellow signals circuits of switch packs 2, 4, 6 and 8 shall be available at a Molex Type 1375 receptacle which shall intermate with a Molex Type 1375 plug to allow flash programming. Plug Connector, with programming jumpers, shall be furnished for each circuit to allow red or yellow flash programming. Connectors shall be readily accessible without the removal of any other equipment.

- 4.8 The Monitor Connector shall be a rigidly supported printed circuit board edge connector, having two rows of 28/56 independent double readout bifurcated contacts on 0.156-inch centers. The connector shall intermate with the Monitor Unit Model 210.
- 4.9 It shall be possible to remove the monitoring device without causing the intersection to go into flashing operation. The cabinet shall be wired so that with the front cabinet door closed and with the monitor unit removed, the intersection shall go into flashing operation. The cabinet shall contain a conspicuous warning against operation with the monitor unit removed.
- 4.10 The monitor unit connector shall be wired in accordance with the pin assignment shown on the plans.
- 5. Flash Transfer Relay
  - 5.1 Flash transfer relays shall conform to the requirements for heavy-duty relays.
  - 5.2 A leakage resistor, which will permit a small amount of current to pass through the relay coil if the contacts should remain closed after the coil circuit is opened, shall be installed across the terminals of the relay socket to overcome the residual magnetism effects.
  - 5.3 The coil of the flash transfer relay shall be energized only when the signals are in flashing operation.
  - 5.4 The flash transfer relay shall transfer switch pack output to flash control. Transfer of the flash transfer relay circuit to flash control shall not prohibit the operation of the controller unit.
- 6. Police Panel
  - 6.1 A police panel shall be mounted behind the police panel door. The panel shall contain 2 DPDT toggle switches. One switch shall be labeled "ON-OFF" and the other shall be labeled "FLASH/AUTOMATIC". The "ON-OFF" switch shall be positioned so that the "ON" position is up.

6.2 The switches shall have contacts rated for 15 amperes at 120 volts AC.

6.3 The front and back of the panel shall be enclosed with a rigid metal covering so that no parts having line voltage are exposed.

## 7. Side Panels

7.1 Two panels shall be provided and mounted on the EIA rack parallel to the cabinet sides as shown on the plans.

7.2 In viewing from the back door, the left side panel shall be designated as the "Input Panel" and the right side panel shall be designated as the "Service Panel".

7.3 All input field terminal blocks for detector field cables and other input conductors, except service conductors, shall be mounted on the "Input Panel".

## 8. General

8.1 A minimum of 10.5 inches of EIA rack height and 20 inches of depth (18 inches behind and 2 inches in front of the mounting ears) shall be provided for the Model 170 Controller Unit.

8.2 The following equipment shall be completely removable from the cabinet without removing any other equipment and using only a common screw driver:

Power Supply  
Power Distribution Assembly  
Input File  
Output File

8.3 All fuses, circuit breakers, switches, (except Police Panel Switches & Fan Fuse) and indicators shall be readily visible and accessible when the front door is open.

8.4 The cabinet shall be delivered for testing mounted on a 5/8-inch thick plyboard shipping pallet. The pallet shall be bolted to the cabinet base. Pallet construction and dimensions shall be as shown on the plans. The cabinet shall be enclosed in a slipover cardboard packing shell.

- 8.5 All equipment in the cabinet shall be clearly and permanently labeled.
- 8.6 Transient suppression shall be provided at the relay bases (across relay coils) and in the fan circuit.

## 9. Connectors

- 9.1 Connector C1P shall contain 104 pin contacts and shall intermate with Connector C1S mounted on the controller unit chassis. Corner guide pins for Connector C1P shall be stainless steel and shall be 1.097 inches in length. Corner guide socket assemblies shall be stainless steel and shall be 0.625-inch in length.
- 9.2 Connector C4 shall contain 37 contacts and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. The plug Connector C4P shall be mounted on the Output File. Contact assignments are shown on the plans.
- 9.3 Connector C5 shall contain 24 contacts, and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. The plug Connector C5P shall be mounted on the Input File. Contact assignments are shown on the plans.
- 9.4 Connector blocks for Connector C1 pin and socket connectors shall be constructed of diallyl phthalate or better. Contacts shall be secured in the blocks with springs of stainless steel.

## 10. Cabinet Wiring Diagram

- 10.1 Four sets of non-fading cabinet wiring diagrams shall be supplied with each cabinet. The diagrams shall be non-proprietary. They shall identify all circuits in such a manner as to be readily interpreted. The cabinet drawing shall show the component layout in an elevation view as viewed from the rear of the cabinet with the left and right cabinet walls shown in their

relative positions. The diagrams shall be placed in a heavy-duty side-opening clear plastic pouch and attached to the cabinet door. The pouch shall be of such design and material that it provides adequate storage and access to the wiring diagram.

- 10.2 Detailed equipment layout scale drawings and wiring diagrams of all equipment installed in the cabinet shall be submitted to the State for approval prior to production. Review by the State does not lessen the Vendor's responsibility to meet the specifications.

## SECTION IV

### CABINET WIRING

#### 1. Conductors

- 1.1 Conductors in the controller cabinet between the service terminals and the signal bus breakers including the signal light grounded conductor shall be No. 8, or larger.
- 1.2 All conductors used in controller cabinet wiring shall be No. 22, or larger, with a minimum of 19 strands. Conductors shall conform to Military Specification: MIL-W-16878D, Type B or better. The insulation shall have a minimum thickness of 10 mils and shall be nylon jacketed polyvinyl chloride except that conductors No. 14 and larger may be UL Type THHN, with a minimum of seven strands.
- 1.3 The loop detector lead-in, from the field terminals in the cabinet to the sensor unit rack connector shall be a cable containing two No. 22, or larger, conductors, with each conductor insulated with either (1) a minimum of 10 mils of polyvinyl chloride and two mils of nylon, or (2) a minimum of 14 mils of polyethylene or polypropylene. The conductors shall be twisted and the twisted pair shall be protected with a shield. The shield or a stranded tinned copper drain wire shall be connected to a terminal on the input file terminal block. This input terminal shall be connected to the equipment grounding bus through a single conductor. The cable shall be provided with a polyethylene or polyvinyl chloride outer jacket with a minimum thickness of 20 mils, or with a chrome vinyl outer jacket with a minimum thickness of 25 mils.

- 1.4 All conductors, except those which can be readily traced, shall be labeled. Labels attached to each end of the conductor shall identify the destination of the other end of the conductor.
- 1.5 All conductors used in controller cabinet wiring shall conform to the following color-code requirements:
  - (a) The grounded conductors of AC circuits shall be identified by a continuous white or natural gray color.
  - (b) The equipment grounding conductors shall be identified by a solid green color or by a continuous green color with one or more yellow stripes.
  - (c) The DC logic ground conductors shall be identified by a solid white color with a colored (except green) stripe.
  - (d) The ungrounded conductors shall be identified by any color not specified in (a), (b) or (c) above.
- 1.6 All cabinet wiring harnesses shall be neat, firm and routed to minimize crosstalk and electrical interference. Printed circuit mother boards may be used to eliminate or reduce cabinet wiring.
  - (a) Wiring containing AC shall be routed and bundled separately or shielded separately from all logic voltage control circuits.
  - (b) Cabling shall be routed to prevent conductors from being in contact with metal edges. Cabling shall be arranged so that any removable assembly may be removed without disturbing conductors not associated with that assembly.
- 1.7 All conductors, terminals or parts, which could be hazardous to maintenance personnel, shall be protected with suitable insulating material.

- 1.8 Within the cabinet wiring, the DC logic ground and equipment ground shall be electrically isolated from the AC grounded conductor and each other by 500 megohms when tested at 250 volts DC, with the power line surge protector disconnected.
- 1.9 Conductors from Connector C1 to the Input Files shall be of sufficient length to allow any conductor to be connected to any detector output terminal.
- 1.10 The AC-copper terminal bus shall not be grounded to the cabinet or connected to logic ground and shall provide a minimum of 10 terminals for connection of field conductors. Minimum 1/4" - nylon screws shall be used for securing bus to service panel.
- 1.11 An equipment grounding (earth ground) bus shall be provided in each cabinet. The bus shall be copper and grounded to the cabinet.
- 1.12 One side of the load side of the cabinet power supply shall be connected to the D.C. logic ground bus using a No. 14, or larger, stranded copper wire.
- 1.13 The DC logic ground bus shall be provided on the input panel as shown on the plans.
- 1.14 A No. 8 or larger conductor shall be connected between equipment ground bus and rack rails.

## 2. Terminal Blocks

- 2.1 Terminal blocks shall be provided for terminating field conductors.
- 2.2 The terminal blocks for detector field conductors auxiliary field wires and control wires shall be the barrier type with marker strips and shall be provided with 8-32 x 5/16-inch minimum nickel plated brass binder head screws and inserts.
- 2.3 The terminal blocks for field wires to the signal indications, power distribution assembly and the required unused position shall be the barrier type with marker strips and shall be provided with 10-32 X 5/16-inch nickel plated brass binder head screws and inserts.

- 2.4 The terminal blocks shall be readily accessible through the cabinet rear door and shall be rated for 20 amperes at 1000 volts RMS, minimum.

The terminal blocks for the input file and and power supply shall be the barrier type with marker strips and shall be provided with 6-32 X 5/16-inch nickel plated brass binder head screws and inserts.

The terminals of the power line service terminal block shall be labeled "L1" and "AC-", and shall be covered with a clear insulating material to prevent inadvertent contact. Terminating lugs large enough to accommodate No. 2 conductors shall be furnished for the service terminal block. The terminal block shall be rated for 50 amperes at 1000 volts, minimum.

#### MISCELLANEOUS SECTION V

### 1. Power Line Surge Protectors

- 1.1 Power line surge protectors shall be provided between both line conductors (AC+ and AC-g) and equipment ground. The protectors shall be installed at the service terminal block.
- 1.2 One surge protector shall be a Three-Electrode Gas Tube Type and shall have the following ratings:
- (a) Impulse Breakdown: less than 1000 volts in less than 0.1 microseconds at 10 kilovolts/microsecond.
  - (b) Standby Current: less than one milliamper.
  - (c) Striking Voltage: greater than 212 volts DC.
  - (d) Capable of withstanding 15 pulses of peak current each of which will rise in eight microseconds and fall in 20 microseconds to one half the peak voltage at 3 minute intervals. Peak current rating shall be 20,000 amperes.
- 1.3 Two Metal Oxide Varistors (MOV) shall be provided; One between AC+ and equipment ground and the other between AC- and equipment ground. The protectors shall have the following ratings:

Recurrent peak voltage-212 volts  
Energy rating maximum-20 joules  
Power dissipation-average 0.85 watts  
Peak current for pulses-2000 amperes for less than 6 microseconds  
Stand-by current-less than 1 milliamp



CHAPTER 12  
SPECIFICATIONS FOR CABINET

MODEL 334  
(RAMP METERING)

This Chapter defines the specifications applicable to the Model 334 Cabinet. These specifications shall supplement the General Specifications for Traffic Control Equipment, and in case of conflict the specifications of this Chapter shall govern.

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SPECIFICATIONS FOR CABINET  
MODEL 334

SECTION I

CABINET CONSTRUCTION

1. The cabinet shall be a rainproof cabinet with dimensions as shown on the Plans.
2. The cabinet and doors shall be fabricated from either 0.073-inch minimum thickness cold rolled sheet steel, or 0.125-inch minimum thickness sheet aluminum. All exterior seams for steel cabinet and doors shall be continuously welded.
  - 2.1 All exterior welds shall be ground smooth.
3. Cabinets shall be finished with a polymeric or an enamel coating system conforming to Color No. 14672 of Federal Standard 595a. All coatings shall be commercially smooth, substantially free of flow lines, paint washout, streaks, blisters, and other defects that would impair serviceability or detract from general appearance. The coatings shall comply with the following requirements:
  - 3.1 Coating Hardness -- the finish shall have a pencil lead hardness of HB minimum using an Eagle Turquoise pencil.
  - 3.2 Salt Spray Resistance -- The undercutting of the film of the coating system shall not exceed 1/8-inch average, from lines scored diagonally and deep enough to expose the base metal, after 350 hours exposure in a salt spray cabinet in accordance with ASTM Designation: B 117.
  - 3.3 The cabinet shall suffer no coating loss when subjected to the following: Two test specimens, four inches by eight inches, of the same material and coating as the cabinet supplied, shall be furnished for the tests. Two 9-inch diagonal scratches exposing bare

metal will be made on a specimen. It will be soaked in demineralized water for 192 hours. A one-inch wide strip of masking tape shall be tightly affixed to this surface and removed with one quick motion, evidence of blistering, softening, or peeling of the paint and/or coating from the base metal shall be cause for rejection.

- 3.4 Metal preparation shall be the 3-step Iron Phosphate Conversion Coating Bonderizing Technique.
- 3.5 The inside walls, doors and ceiling of the housing shall be painted the same as the outside finish.
4. The cabinet shall have single front and rear doors each equipped with a lock. When each door is closed and latched, the door shall be locked. The latching handles shall have provision for padlocking in the closed position. The lock shall be compatible with those in current use for traffic signal controller cabinets by the State. Two keys shall be furnished with each cabinet. The operating handle shall be cast aluminum or cadmium plated steel with 7.5-inch handle and 0.625-inch shank. The cabinet door frame shall be double-flanged out on all four sides and shall provide strikers to hold tension and form a firm seal between door gasketing and cabinet door frame.
5. The latching mechanism shall be a 3-point draw roller type. The center catch and pushrods shall be cadmium plated. Pushrods shall be turned edgewise at the outward supports and shall be 0.25 inch by 0.75 inch, minimum. Supports shall be 0.105-inch steel, minimum. Rollers shall have a minimum diameter of 0.875 inch and shall be equipped with ball bearings and nylon wheels. The center catch shall be fabricated of 0.1875-inch steel, minimum. Details of alternative designs shall be submitted for review and approval prior to the fabrication of the cabinets.
6. Each door's hinging shall be either a single continuous hinge or 4 butt hinges. Each hinge shall have a fixed pin. Front and rear doors shall be provided with catches to hold the door open at 90 degrees and 180 degrees, plus or minus ten degrees. The catches shall be 0.375-inch diameter minimum, cadmium plated steel rods. The catches shall be capable of holding the door open at 90° in a 60 mph wind at an angle pendicular to the plane of the door.

Door hinges, pins, & bolts shall be made of stainless steel. The hinges shall be bolted to the cabinet. The hinge pins and bolts shall not be accessible to vandals.

7. The cabinet shall be provided with 2 lifting eyes to be used when placing the cabinet on the foundation. The lifting eyes shall be located as shown on the plans. Each eye shall have a minimum diameter of 3/4-inch and shall be capable of lifting 1000 pounds.
8. Each cabinet shall be provided with louvered vents in the front door with a removable and reuseable metal air filter 16 inches wide by 12 inches long by 0.875-inch deep. The filter shall cover the vents and shall be held firmly in place with bottom and side brackets and a spring-loaded upper clamp.

The bottom filter bracket shall be formed into a waterproof sump with drain holes to the outside. The louvered vents shall be designed and constructed such that a stream of water from a pressure head, such as a Rainbird sprinkler or other type sprinkler, will not enter the cabinet. The louvered area shall be less than or equal to the filtered area.

9. The police panel door shall be equipped with a lock keyed for a master police key. The police panel shall be mounted on the side of the cabinet as shown on the plans.

Two keys shall be furnished with each cabinet for the police lock. Each police key shall have a shaft at least 1-3/4 inches in length.

10. A standard EIA 19-inch rack shall be installed inside the cabinet for mounting the controller unit, input files, power supply, output file and power distribution assembly. The EIA rack shall consist of two pair of full length, continuous, adjustable equipment mounting angles of 0.1345-inch nominal thickness cadmium plated steel tapped with 10-32 threads with EIA universal spacing. The angles shall comply with Standard EIA RS-310-B.

Two cadmium plated Controller Unit supporting angles extending from the front to the back rails shall be

supplied to support the controller unit. The angles shall be designed to support a minimum of 50 pounds each. The horizontal side of each angle shall be a minimum of three inches. The angles shall be mounted 17.5 inches from the top of the rack and shall be adjustable vertically.

11. Gasketing shall be provided on all door openings and shall be dust-tight. Gaskets shall be 0.25 inch min. thickness closed cell neoprene and shall be permanently bonded to the metal. The mating surface of the gasketing shall be covered with a silicone lubricant to prevent sticking to the mating surface.

The cabinet base layout shall accommodate the anchor bolts and conduits as shown on the plans.

## SECTION II

### CABINET VENTILATION REQUIREMENTS

1. Each cabinet shall be equipped with an electric fan with ball or roller bearings and a capacity of at least 100 Cubic Feet of Air per Minute.
  - 1.1 The fan shall be mounted within the cabinet and vented out between the top of the cabinet and the front door as shown on the plans.
  - 1.2 The fan shall be thermostatically controlled and shall be manually adjustable to turn on between 33° C and 65° C with a differential of not more than 6° C between automatic turn on and turn off. The cabinet fan circuit shall be fused at 125 percent of the ampacity of the fan motor.
  - 1.3 Intake (including filter) and exhaust areas shall pass a minimum of 60 cubic feet of air per minute.

## SECTION III

### CABINET ACCESSORIES

1. Power Supply
  - 1.1 A power supply shall be provided in the cabinet to operate all equipment installed in the cabinet except the controller unit.
  - 1.2 The power supply shall utilize no more than 7 inches of rack height and have a maximum depth of 6 inches from the front surface of the front rails.

- 1.3 The power supply shall be of ferro-resonant design having no active components and shall conform to the following requirements:
  - a. Line Regulation: Two percent from 95 to 135 VAC at 60 hertz, plus an additional 1.6 percent for each additional one percent frequency change.
  - b. Load Regulation: Five percent from 1 ampere to 5 amperes with a maximum temperature rise of 30° C above ambient.
  - c. Design Voltage: +24+0.3 volts DC at 1/2 load and 40° C.
  - d. Full Load Current: Five amperes, minimum.
  - e. Ripple Noise: 2 volts peak-to-peak and 500 millivolts rms at full load.
  - f. Line Voltage: 95 to 135 VAC.
  - g. Efficiency: 60 percent, minimum.
  - h. Minimum Voltage: 22.8 VDC.
- 1.4 The power supply front panel shall include:
  - a. All fuses or circuit breakers
  - b. Pilot Lamp
  - c. Test points or meter for monitoring output voltage.
- 1.5 The power supply shall be enclosed to prevent accidental contact with energized parts.

## 2. Input File

- 2.1 Each input file shall utilize 5.25 inches of rack height. Each input file shall intermate with and support 14 two-channel loop detector units.
- 2.2 The input file shall provide card guides (top and bottom) and a 22-pin on edge-connector centered vertically for each detector. The input file shall allow air circulation through the top and bottom.

- 2.3 Pins D, E, J, & K on each edge connector shall be wired to the field terminals to provide for 22 loop detector channels or one magnetometer channel.
  - 2.4 Loops #1 and #2 output collectors and emitters (pins F, H, W and X) for each slot shall terminate on a terminal block mounted on the rear of the input file and shall connect to the proper controller unit inputs in the Connector C1S wiring harness. Common grounding of output emitters will be permitted.
  - 2.5 The input file shall be connected as shown on the plans.
  - 2.6 The edge connectors shall be double sided connectors with the numbered side of each pin shorted to its respective lettered side internally.
  - 2.7 A minimum of 1/2-inch clearance shall be maintained between the card guide and the face of the file.
  - 2.8 The input file shall be provided with marker strips to identify items on the file. The marker strips shall be of a material that can be easily and legibly written on using a pencil or ball point pen. Marker strips shall be located immediately below the items they are to identify.
3. Output/Power Distribution Assembly
- 3.1 The output/power distribution assembly shall be furnished and mounted on the EIA 19-inch rack utilizing 7 inches of rack height. All equipment shall be readily accessible for ease of replacement. The depth of the assembly shall not exceed 10 inches from the front rails.
  - 3.2 The output/power distribution Assembly shall be provided with marker strips to identify items in the Assembly. The marker strips shall be of a material that can be easily and legibly written on using a pencil or ball point pen. Marker strips shall be located immediately below the items they are to identify.

- 3.3 The following equipment shall be provided with the assembly:
- 1 - Equipment Circuit Breaker
  - 2 - Equipment receptacles (one on the front panel, and another on the back panel readily accessible from back door)
  - 1 - Controller unit receptacle
  - 1 - Single pole main circuit breaker
  - 1 - Nine position signal field wire terminal block
  - 1 - Twelve position (minimum) assembly terminal block
  - 1 - Watchdog timer
  - 1 - Watchdog inhibit switch
  - 1 - Transfer relay and socket
  - 3 - Switch pack socket
  - 1 - Watchdog error indicator light
- 3.4 The equipment circuit breaker shall be rated for 15 amperes at 120 volts AC.
- 3.5 The main circuit breaker shall be rated for 30 amperes at 120 volts AC.
- 3.6 Equipment receptacles shall be a duplex NEMA Type 5-15R.
- 3.6.1 The equipment receptacles shall have ground-fault circuit interruption as defined in the National Electrical Code. Circuit interruption shall occur on 6 milliamperes of ground-fault current and shall not occur on less than 4 milliamperes of ground-fault current.
- 3.7 A watchdog timer shall be furnished and installed in the assembly as shown on the plans. The watchdog timer output from the controller unit will change state every 100 milliseconds under program control. Failure to receive this change of state for one



second + 10 percent shall cause the watchdog timer to open a output switch. The output switch shall be either solid state or electrical-mechanical rated for 10 amperes at 120 volts AC. Power failures of 50 milliseconds or greater shall not cause the watchdog timer to trip.

- 3.8 A watchdog muzzle switch shall be provided to inhibit the watchdog timer operations.

The switch shall be a single pole, single throw toggle switch rated for 15 amperes at 120 volts AC.

- 3.9 A lamp indicating "WD Timer Error" shall be provided on the front panel of the assembly. The lamp shall be driven by the output from the watchdog timer.

- 3.10 The controller unit receptacle shall be a NEMA Type -15R mounted on the back panel of the assembly.

- 3.11 Terminal blocks shall be provided and mounted on the back panel of the assembly. The blocks shall be of the type specified for signal field wire terminal blocks. Two spare positions shall be provided on the assembly-block. All conductors from the Output/Power Distribution Assembly shall be routed to the cabinet wiring shall be connected to the assembly terminal block on a common side, except for the AC power conductor between the service terminal block and main circuit breaker. All internal conductors terminating at the blocks shall be connected to the other side of the blocks.

- 3.12 The controller unit outputs shall be connected to the Output/Power Distribution Assembly via Connector C4. Connector C4P shall be mounted as shown on the plans to mate with its associated cabinet harness connector, Connector C4S.

### 3.13 Transfer Relay

- 3.13.1 Transfers relays shall conform to the requirements for Heavy Duty Relays.

A leakage resistor, which will permit a small amount of current to pass through relay coil if the contacts should remain closed after the coil circuit is opened, shall be installed across the terminals of the relay socket to overcome the residual magnetism effect.

#### 4. Police Panel

- 4.1 A police panel shall be mounted behind the police panel door. The panel shall contain 2 DPST toggle switches. One switch shall be labeled "ON-OFF"- "LIGHTS", and the other switch labeled "POLICE CONTROL", "ON-OFF". The switches shall be positioned so that the "ON" position is up.
- 4.2 The switches shall have contacts rated for 15 amperes at 120 volts AC.
- 4.3 The front and back of the panel shall be enclosed with a rigid metal covering so that no parts having line voltage are exposed.

#### 5. Side Panels

- 5.1 Two panels shall be provided and mounted on the EIA rack parallel to the cabinet sides as shown on the plans.
- 5.2 In viewing from the back door, the left side panel shall be designated as the "Input Panel" and the right side panel shall be designated as the "Service Panel".
- 5.3 All input field terminal blocks for detector field cables and other input conductors, except service conductors, shall be mounted on the "Input Panel".

#### 6. General

- 6.1 A minimum of 10.5 inches of EIA rack height and 20 inches of depth (18 inches behind and 2 inches in front of the mounting ears) shall be provided for the Controller Unit.
- 6.2 The following equipment shall be completely removable from the cabinet without removing any other equipment and using only a common screw driver:

Power Supply  
Output/Power Distribution Assembly  
Input File

- 6.3 All fuses, circuit breakers, switches, (except Police Panel Switches & Fan Fuse) and indicators shall be readily visible and accessible when the front door is open.

- 6.4 The cabinet shall be delivered for testing mounted on a 5/8-inch thick plyboard shipping pallet. The pallet shall be bolted to the cabinet base. The pallet construction and dimensions shall be as shown on the plans. The cabinet shall be enclosed in a slipover cardboard packing shell.
- 6.5 All equipment in the cabinet shall be clearly and permanently labeled.
- 6.6 Transient suppression shall be provided at the relay bases (across relay coils) and in the fan circuit.

## 7. Connectors

- 7.1 Connector C1P shall contain 104 pin contacts and shall intermate with Connector C1S mounted on the controller unit chassis. Corner guide pins for Connector C1P shall be stainless steel and shall be 1.097 inches in length. Corner guide socket assemblies shall be stainless steel and shall be 0.625 inch in length.
- 7.2 Connector C6 shall contain 24 contacts and shall be circular plastic type with quick connect/disconnect capability with thread assist, positive detect coupling. The plug Connector C6P shall be mounted on the Output/Power Distribution Assembly.
- 7.3 Connector C5 shall contain 24 contacts, and shall be the circular plastic type with quick connect/disconnect capability and thread assist, positive detect coupling. The plug Connector C5P shall be mounted on the Input File. Contact assignments are shown on the plans.
- 7.4 Connector blocks for Connector C1 pin and socket connectors shall be constructed of diallyl phthalate or better. Contacts shall be secured in the blocks with springs of stainless steel.

## 8. Cabinet Wiring Diagram

- 8.1 Four sets of non-fading cabinet wiring diagrams shall be supplied with each cabinet. The diagrams shall be non-proprietary. They shall identify all circuits in such a manner as to be readily interpreted. The cabinet drawing shall show the component layout in an elevation view as viewed from the rear of the cabinet

with the left and right cabinet walls shown in their relative positions. The diagrams shall be placed in a heavy-duty, side-opening, clear plastic pouch and attached to the cabinet door. The pouch shall be of such design and material that it provides adequate storage and access to the wiring diagram.

- 8.2 Detailed equipment layout scale drawings and wiring diagrams of all equipment installed in the cabinet shall be submitted to the State for approval prior to production. Review by the State does not lessen the Vendor's responsibility to meet the specifications.

## SECTION IV

### CABINET WIRING

#### 1. Conductors

- 1.1 Conductors in the controller cabinet between the service terminals and the Output/Power Distribution Assembly including the grounded conductor shall be No. 8, or larger.
- 1.2 All conductors used in controller cabinet wiring shall be No. 22, or larger, with a minimum of 19 strands. Conductors shall conform to Military Specification: MIL-W-16878D, Type B or better. The insulation shall have a minimum thickness of 10 mils and shall be nylon jacketed polyvinyl chloride except that conductors No. 14 and larger may be UL Type THHN, with a minimum of seven strands.
- 1.3 The loop detector lead-in, from the field terminals in the cabinet to the sensor unit rack connector shall be a cable containing two No. 22, or larger, conductors, with each conductor insulated with either (1) a minimum of 10 mils of polyvinyl chloride and two mils of nylon, or (2) a minimum of 14 mils of polyethylene or polypropylene. The conductors shall be twisted and the twisted pair shall be protected with a shield. The shield or a stranded tinned copper drain wire shall be connected to a terminal on the input file terminal block. The field input terminal shall be connected to the equipment grounding bus through a single conductor. The cable shall be provided with a polyethylene or polyvinyl chloride outer jacket with a minimum thickness of 20 mils, or with a chrome vinyl outer jacket with a minimum thickness of 25 mils.

- 1.4 All conductors, except those which can be readily traced, shall be labeled. Labels attached to each end of the conductor shall identify the destination of the other end of the conductor.
- 1.5 All conductors used in controller cabinet wiring shall conform to the following color-code requirements:
  - (a) The grounded conductors of AC circuits shall be identified by a continuous white or natural gray color.
  - (b) The equipment grounding conductors shall be identified by a solid green color or by a continuous green color with one or more yellow stripes.
  - (c) The DC logic ground conductors shall be identified by a solid white color with a colored (except green) stripe.
  - (d) The ungrounded conductors shall be identified by any color not specified in (a), (b) or (c) above.
- 1.6 All cabinet wiring harnesses shall be neat, firm and routed to minimize crosstalk and electrical interference. Printed circuit mother boards may be used to eliminate or reduce cabinet wiring.
  - 1.6.1 Wiring containing AC shall be routed and bundled separately or shielded separately from all logic voltage control circuits.
  - 1.6.2 Cabling shall be routed to prevent conductors from being in contact with metal edges. Cabling shall be arranged so that any removable assembly may be removed without disturbing conductors not associated with that assembly.
- 1.7 All conductors, terminals or parts, which could be hazardous to maintenance personnel, shall be protected with suitable insulating material.
- 1.8 Within the cabinet wiring, the DC logic ground and earth ground shall be electrically isolated from the AC grounded conductor and each other by 500 megohms when tested at 250 volts DC, with the power line surge protector disconnected.

- 1.9 Conductors from Connector C1 to the Input Files shall be of sufficient length to allow any conductor to be connected to any detector output terminal.
- 1.10 The AC- copper terminal bus shall not be grounded to the cabinet or connected to logic ground and shall provide a minimum of 10 terminals for connection of field conductors. Minimum 1/4 inch nylon screws shall be used for securing bus to service panel.
- 1.11 An equipment grounding (earth ground) bus shall be provided in each cabinet. The bus shall be copper and grounded to the cabinet.
- 1.12 One side of the load side of the cabinet power supply shall be grounded to the D.C. logic ground bus using a No. 14, or larger, stranded copper wire.
- 1.13 The DC logic ground bus shall be provided on the input panel as shown on the plans.
- 1.14 A #8 conductor shall be connected between the equipment ground bus and the rack rails.

## 2. Terminal Blocks

- 2.1 Terminal blocks shall be provided for terminating field conductors.
- 2.2 The terminal blocks for detector field conductors, & auxiliary field wires shall be the barrier type with marker strips and shall be provided with 8-32 x 5/16-inch minimum nickel plated brass binder head screws and inserts.
- 2.3 The terminal blocks for field wires to the signal indications, for the output/power distribution assembly and the required unused positions shall be the barrier type with marker strips and shall be provided with 10-32 X 5/16-inch nickel plated brass binder head screws and inserts.
- 2.4 The terminal blocks shall be readily accessible through the cabinet rear door and shall be rated for 20 amperes at 1000 volts RMS, minimum.
- 2.5 The terminal blocks for the input file and power supply shall be the barrier type with marker strips and shall be provided with 6-32 X 5/16-inch nickel plated brass binder head screws and inserts.

- 2.6 The terminals of the power line service terminal block shall be labeled "L1" and "AC-", and shall be covered with a clear insulating material to prevent inadvertent contact. Terminating lugs large enough to accommodate No. 2 conductors shall be furnished for the service terminal block. The terminal block shall be rated for 50 amperes at 1000 volts, minimum.

## SECTION V

### MISCELLANEOUS

#### 1. Power Line Surge Protectors

- 1.1 Power line surge protectors shall be provided between both line conductors (AC+ and AC-) and equipment ground. The protectors shall be installed at the service terminal block.

- 1.1.1 One surge protector shall be a Three-Electrode Gas Tube Type and shall have the following ratings:

- (a) Impulse Breakdown: less than 1000 volts in less than 0.1 micro-seconds at 10 kilovolts/ microsecond.
- (b) Standby Current: less than one milli-ampere.
- (c) Striking Voltage: greater than 212 volts DC.
- (d) Capable of withstanding 15 pulses of peak current each of which will rise in eight microseconds and fall in 20 microseconds to one half the peak voltage at 3 minute intervals. Peak current rating shall be 20,000 amperes.

- 1.1.2 Two Metal Oxide Varistors (MOV) shall be provided; one between AC+ and Equipment ground and the other between AC- and Equipment ground. The protectors shall have the following ratings:

Recurrent peak voltage--212 Volts  
Energy rating maximum--20 joules  
Power dissipation--average 0.85 Watts  
Peak current for pulses--20,000 amperes for less than 6 microseconds  
Standby current--less than 1 milliamp

## 2. Visual Alarm Light

- 2.1 A vandal resistant visual alarm light shall be mounted on the roof of the cabinet as shown on the plans. The light shall be actuated by one of the switch pack outputs and by the transfer relay. The light shall be visible from 360 degrees, shall be waterproof and corrosion resistant, shall have a blue acrylic plastic lens and shall be provided with a 120V, 15 watt, incandescent bayonet base lamp. Lens cover shall be 2.5 inches in diameter and 1.75 inches in height. The fixture shall be secured to the cabinet with a minimum of two screws.



## CHAPTER 13

### PROGRAMMING SYSTEM

This Chapter defines the specifications applicable to the Programming System to be used with Model 170 controller unit Memories. These specifications shall supplement the General Specifications for Traffic Control Equipment and in case of conflict the specifications of this Chapter shall govern.

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## PROGRAMMING SYSTEM

The programming system shall be a portable device designed for programming the following PROM's; Intel 2708, Signetics SN2708 and Motorola MCM 68708. The programming system shall use a microprocessor and include the following features:

1. Hexadecimal keyboard for address and data entries.
2. Hexadecimal display for displaying address or data.
3. Provision to read out and display data in a PROM chip, a word at a time.
4. Provision to duplicate data from one PROM chip to another. Duplication time shall be less than 2 minutes.
5. Automatic comparison and verification of data between two PROM chips. The programming system shall halt on a mismatch, and display the address of the mismatch and the data in both chips at that address.
6. Compartment with a built-in ultraviolet light source for erasing data in 6 or more PROM chips simultaneously. The time required to erase PROM chips shall be less than 60 minutes. The ultraviolet light shall be switched off with an automatic timer.

The ultraviolet light source shall be covered. It shall automatically switch off if the light is uncovered.

7. The sockets that house the PROM chips during reading or writing processes shall require zero force for insertion or removal of the PROM chip.

## CHAPTER 14

### SPECIFICATIONS FOR MODEM MODEL 400

This Chapter defines the specifications applicable to the MODEM, Model 400, to be used with Model 170 controller units. These specifications shall supplement the General Specifications for Traffic Control Equipment and in case of conflict the specifications of this Chapter shall govern.

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## 1. MODEM

- 1.1 The MODEM shall provide for 1-way or 2-way, 2-wire half duplex and 4-wire full duplex communications.
- 1.2 The MODEM Board dimensions, space limitations, and connections shall be as shown on the Plans.
- 1.3 The MODEM shall comply with the following requirements:
  - 1.3.1 Data Rate: Serial, 300 to 1200 Baud Modulation
  - 1.3.2 Modulation: Frequency Shift Keying (FSK)
  - 1.3.3 Operation: Asynchronous
  - 1.3.4 Line and signal Requirements: Type 3002 Voice-grade
  - 1.3.5 Interface: EIA RS-232-C Standards
  - 1.3.6 Tone Carrier Frequencies: 1200 Hz - 2200 Hz
  - 1.3.7 Transmitting Output Signal Level: 0,-2,-4,-6, & -8 dbm continuous or switch selectable.
  - 1.3.8 Received Input Sensitivity: 0 to -40 dbm
  - 1.3.9 Receiver Bandpass Filter: shall provide a minimum of 20 db attenuation at frequencies outside the operating band.
  - 1.3.10 Clear-to-Send Delay: Turn around time of 10 milliseconds
  - 1.3.11 Carrier Response Time: 8 milliseconds
  - 1.3.12 Soft Carrier Turn off Time: 10 milliseconds
  - 1.3.13 MODEM Recovery Time: capable of receiving data within 10 milliseconds after completion of transmissions.
  - 1.3.14 Error Rate: not to exceed 1 bit in  $10^5$  bits with a signal to noise ratio of 16 db with noise flat weight over a 300 to 3400 Hz band.
  - 1.3.15 ACIA Interface: comply with EIA RS-232-C Standards

1.3.16 Transmit Noise: less than -50 db across 1600 ohm resistive load within the frequency Spectrum of 300 to 3000 Hz at maximum output.

1.4 Communications shall be switch selectable between half and full duplex.

1.5 The MODEM power requirements are as follows:

<u>INPUT VOLTAGES</u>	<u>MAXIMUM CURRENT</u>
+12 VDC	150 Milliamperes
-12 VDC	150 Milliamperes

1.6 Indicators shall be provided on the front edge of the MODEM indicating Carrier Detect, Transmit Data, and Receive Data.

1.7 Must interface to and operate in Type 170 controller unit.

1.8 Must decode California test program correctly.

## CHAPTER 15

### SPECIFICATIONS FOR DIAGNOSTIC PROM MODULE MODEL 410

This Chapter defines the specifications applicable to the Diagnostic PROM Module-Model 410. These specifications shall supplement General Specifications for Traffic Control Equipment and in case of conflict, the specifications of this Chapter shall govern.

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## CHAPTER 16

### SPECIFICATIONS FOR AUXILIARY OUTPUT FILE MODEL 420

This Chapter defines the specifications applicable to the Auxiliary Output File - Model 420. These specifications shall supplement the General Specifications for Traffic Control Equipment and in case of conflict the specifications of this Chapter shall govern.

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## AUXILIARY OUTPUT FILE MODEL 420

### SECTION I

#### AUXILIARY OUTPUT FILE

1. The Auxiliary Output File shall utilize 5.25 inches of rack height and shall be capable of containing six switch packs and two flash transfer relays. Two flash transfer relays shall be provided with the file.
2. Card guides shall be provided to support the switch packs.
3. Switch pack and flash transfer relay sockets shall be readily accessible from the back of the file without the use of tools.
4. Field terminal blocks shall be mounted vertically on the back of the file.
5. Controller unit outputs to the auxiliary output file shall be connected through Connector C5.
6. Connector C5P shall be mounted on the left side of the auxiliary output file back plane located to mate with its associated cabinet harness Connector C5S. Connector C5 contact assignments shall be as shown on the plans.
7. The red and yellow signal circuits of Switch Packs No. 2 and No. 5 shall be made available at a Molex receptacle/plug connection for flash selectability.
8. Flash Transfer Relay
  - 8.1 Flash Transfer Relays shall conform to the requirements for Heavy Duty Relays.
  - 8.2 A leakage resistor, which will permit a small amount of current to pass through the relay coil if the contacts should remain closed after the coil circuit is opened, shall be installed across the terminals of the relay socket to overcome the residual magnetism effects.



- 8.3 The coil of the flash transfer relay shall be energized only when the signals are in flashing operation.
- 8.4 The flash transfer relay shall transfer switch pack output to flash control. Transfer of the flash transfer relay circuit to flash control shall not prohibit the operation of the controller unit.
- 9. Details for mounting of card guides, output file terminal assignments, Molex receptacle/plug connection and Connector C5 contact assignments shall be as shown on the plans.

## CHAPTER 17

### SPECIFICATIONS FOR HEAVY DUTY RELAYS MODEL 430

This Chapter defines the specifications applicable to the Heavy Duty Relay, Model 430. These specifications shall supplement the General Specifications for Traffic Control Equipment and in case of conflict the specifications of this Chapter shall govern.

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SPECIFICATIONS FOR HEAVY DUTY RELAYS  
MODEL 430

1. HEAVY DUTY RELAYS

- 1.1 Heavy duty relays shall be the electromechanical type and shall be designed for continuous duty.
- 1.2 Each relay shall operate in the 8-pin Jones-type socket shown on the plans and shall be enclosed with a removable, clear plastic cover.
- 1.3 Each relay shall be provided with double-pole, double-throw contacts. Contact points shall be of fine silver, silver-alloy or superior alternative material. Contact points and contact arms shall be capable of carrying a current of 20 amperes tungsten load, per contact, at 120 volts AC without undue pitting. Relay coils shall have a power consumption of 10 volt-amperes or less and shall be designed for continuous duty at 120 volts AC.
- 1.4 Each relay shall withstand a potential of 1500 volts at 60 hertz between insulated parts and between current carrying parts and non-current carrying parts.
- 1.5 Each relay shall have a one-cycle surge rating of 175 amperes RMS.
- 1.6 Contacts shall be designed for 1,000,000 operations.

TRAFFIC SIGNAL CONTROL EQUIPMENT SPECIFICATION  
ADDENDUM - NOVEMBER, 1978

This addendum relates to the State of California Department of Transportation "Traffic Signal Control Equipment Specifications, dated April, 1978", and modifies or adds to these specifications.

- A 1. CHAPTER 1, SECTION I - GLOSSARY. Add or amend the following:
- Power Failure - Incoming Line Voltage falls below 95(93+2) Volts, A.C. for 50 milliseconds or more.
- Power Restoration - Incoming Line Voltage rises to 96(98+2) Volts, A.C. for 50 milliseconds or more.
- Mother Board - A Printed Circuit Connector Interface Board with no active or passive components.
- N Vendor - See Contractor.
- N Watchdog Timer - Monitoring circuit external to the Controller Unit which senses a Controller Unit Output Line. No Line Change in State for One Second equates to a Controller Error and a WDT Action as called out in these specifications.
- N 2. CHAPTER 1, SECTION II, Heading 3. Amend Sentence One to read:
- "Two Manuals shall be supplied for each item required under this contract up to a maximum of 400 Manuals."
- N 3. CHAPTER I, SECTION II, 4. Interchangeability.
- a) Amend Paragraph One to read:
- "The following assemblies and associated devices shall electrically and mechanically intermate with each other:"
- b) Amend the Last Paragraph to read:
- "The Model 170 Controller Unit shall be compatible with and intermate to Model 400 MODEM, Model 410 Diagnostic PROM Module, Model 412 System Memory Module, and Controller Cabinet Models 330, 332 and 334."
- N 4. CHAPTER 1, SECTION II, 5.1 Heading. Amend Sentence One to read:
- "All indicators and character displays shall have a cone visibility of +45 degrees from an axis perpendicular to the front panel."

- N 5. CHAPTER 1, SECTION II, Headings 6.3 and 6.4. Amend to read:  
"6.3 Connectors C1, C4 and C5 shall use the AMP #601105-1 or #91002-1 contact insertion tool, and the AMP #305183 contact extraction tool.  
"6.4 Pin and socket contacts for Connectors C1, C4 and C5 shall be beryllium copper construction subplated with 0.00005-inch nickel and plated with 0.00003-inch gold. Pin diameter shall be 0.062 inch."
- N 6. CHAPTER 1, SECTION III, COMPONENTS, Heading 8. Amend to read:  
"8. Encapsulation of two or more discrete components into circuit modules is prohibited, except for transient suppression circuits, resistor packs, diode packs, optical isolators and transistor arrays."
- N 7. CHAPTER 1, SECTION III, COMPONENTS, Heading 14.1. Amend to read:  
"14.1 All power transformers and inductors shall have the manufacturer's part number clearly and legibly printed on the case or frame."
- N 8. CHAPTER 1, SECTION IV, MECHANICAL, Heading 1. Amend to read:  
"1. Assemblies and Printed Circuit Board Design  
1.1 Assemblies (including Controller Unit)--All assemblies shall be easily replaceable and incorporate plug-in techniques for their associated devices or printed circuit boards with the following exceptions: The Cabinet Power Supply or any Mother Board Assemblies. The Type 170 Controller Unit Power Supply may be a plug-in assembly. Assemblies shall be provided with two guides for each plug-in Printed Circuit Board or associated device (except relays). The guides shall extend to within 3/4-inches from the face of either the socket or connector.  
1.2 Printed Circuit Board--No components, traces, brackets or obstructions shall be within 1/8-inch of the board edge (guide edges)."
- N 9. CHAPTER 1, SECTION V, ENGINEERING, Heading 1.4.  
Substitute "Printed Circuit Board" for "Modules" in 1.4 and 1.4.1.
- N 10. CHAPTER 1, SECTION VI, PRINTED CIRCUIT BOARDS.  
a) Amend Heading 1.4.5 to read:

"1.4.5 Where less than 1/4-inch lateral separation is provided between the printed circuit board and any metal surface, a 1/16-inch plastic cover shall be provided to protect the printed circuit board."

b) Add the following heading:

"1.5 Each printed circuit board connector edge shall be chamfered at 30 degrees from board side planes. The key slots shall also be chamfered so that the connector keys shall not be extracted upon removal of board or jammed upon insertion. The Key Slots shall be 0.045 $\pm$ .005 inches for 0.1 Spacing and 0.055 $\pm$ .005 inches for 0.156 Spacing."

A 11. CHAPTER 1, SECTION VIII, Subheading 4.3. Amend to read:

"4.3 All circuits, unless otherwise noted, shall commence operation at, or below, 95 Volts, A.C. as the applied voltage is raised from 50 Volts A.C. to 95 Volts A.C. at a rate not to exceed 3 Volts per Second."

M,A 12. Under CHAPTER 1, Section IX - Plans: Add the plan sheet SES 35A, MODEL 334 CONTROLLER CABINET DETAILS, and modify the following sheets:

N a) Delete "Alpha" reference to Corner Guides under "Connector C1S and P Details". Add the following note:

"The Darker Circles in the block details denote Guide Pin Location and the Open Circles Guide Socket Location."

A b) MODEL 170 CONTROLLER UNIT (Sheet 2)--Modify "VMA" under the Circuit Assignments from PROM Module Connector Detail to read "VMA". Modify Clear Area in Model 170 for PROM Module to show and read "0.70" on both sides of the module board. Add the following Note:

"NOTE: All functions under Connector C2 and Terminal Block T1 are referenced to the MODEM."

N c) MODEL 332 CABINET DETAILS (Sheet 4)--Amend CABINET PALLET and add One Line Cabinet Diagram Option as shown on attached sheet.

d) MODEL 332 CABINET DETAILS (Sheet 5)--Add the following Notes under Input File Wiring Diagram and Input Panel Detail:

A "NOTE: Center to Center Spacing between slots shall be 1.2 inches."

"NOTE: TB2 and TB3 Terminal Blocks shall be mounted below Controller Unit Support Angles."

- N The "Input File Detail" Requirements shown on the attached sheet shall be included as part of this specification.
- A e) MODEL 332 CABINET CONNECTOR DETAILS (Sheet 6)--Amend Pin 18 Source under Connector - C5 Wiring List to read "C1-101".
- A f) CABINET ASSEMBLIES AND AUXILIARY EQUIPMENT DETAILS (Sheet 7)--Add the following note under the Isolation Relay Detail:
- "Switch is Normally Open"
- N Delete "Enclosure for Switch Pack" under Output File Detail and add "Switch Pack Detail" shown on attached sheet to these plan requirements.
- N Amend dimension of 2.5 for monitor module under OUTPUT FILE DETAIL - FRONT VIEW to 1.5".
- A Add "Typical" under Switch Pack Mounting Detail Height Dimension, "4.4".
- A The End View Dimension, 0.2", for the MODEL 210 Monitor Unit is from center of P.C. Board to edge of front panel.
- A Amend the "TA" Terminal Block Assignments shown for the Auxiliary Output File Details as follows:

<u>Position</u>	<u>Function</u>
1	Flasher Unit #2, Ckt. 1
2	Flasher Unit #2, Ckt. 2
3	FR Relay Coil
4	AC - Bus
5	Power, Ckt. #1
6	Power, Ckt. #2
7	Equip. Grnd. Bus.

- N g) MODEL 334 CONTROLLER CABINET DETAILS (Sheet 8)--Amend "Relay, Contacts" under Cabinet One Line Diagram to read:
- "~~—|—~~ Relay, Contact N.C.  
~~—|—~~ Relay, Contact N.O."

Add following Note under Side Panel Detail:

"NOTE: TB2 and TB5 Terminal Blocks shall be mounted on Input Panel below Controller Unit Support Angle."

- A 13. CHAPTER 2, SECTION I, CONTROLLER UNIT REQUIREMENTS:
- a) Heading 6.6 is amended to read:

"When the PROM Module is not being addressed, the data outputs shall be disabled into a high impedance state and the outputs shall not source or sink more than 100 microamperes."

- A        b) Add the following requirement to Heading 6.7:

"PROM Chip Access Time shall be 450 nanoseconds or less over the specified operating temperature range."

- N        c) Add the following to Heading 7.1:

"The RAM Memory shall be Second Sourced."

- A        d) The second sentence in Heading 7.2 is amended to read:

"The battery shall be a nickel-cadmium type, or equivalent, with a rated capacity of 100 milliampere hours, minimum."

- N        e) Amend last sentence of Heading 8.3 to read:

"The interface between the ACIA and the Model 400 MODEM shall comply with EIA-RS-232-C Standards. RTS & TX Data Lines to the MODEM shall have Mark and Space Voltages of -12 and +12 VDC respectively."

- N        f) Amend Heading 9.3 to read:

"A battery charging circuit shall be provided which shall fully recharge within 24 hours and float both the Chassis Standby Battery and the RAM Holdup battery consistent with Battery manufacturer's recommendations. An indicator, located on the front panel, shall be provided to illuminate when the battery charging current exceeds a preset limit indicating that the Chassis Standby Battery is in a "High Charge" Mode."

- N        g) Amend Sentence Two of Heading 10.3 to read:

"The character displays shall be hexadecimal with circuits to accept, store, and display 4-bit binary data."

- A        h) Add a new heading No. 13 to read as follows:

### "13. Data and Address Bus Requirements

13.1 All Data Bus Buffers or Data Bus Drivers shall be tri-state buffered devices enabling them to drive a load consisting of 10 TTL gates and 200 picofarads.

13.2 All Address Bus Inputs shall not load the Bus by more than one TTL gate load and 100 picofarads, and shall be buffered."



A 14. CHAPTER 2, SECTION II, Heading 4.

Amend Sentence One to read:

"Test points shall be provided for monitoring all power supply voltages."

15. CHAPTER 3, SECTION II, FUNCTIONAL REQUIREMENTS.

N a) Add following Sentence under Heading 6:

"Voltages below monitor thresholds for duration of between 200 to 500 milliseconds may or may not trigger the monitor."

A b) Amend Sentence Two of second paragraph under Subheading 7.1 to read:

"The monitor unit upon detection of any failure (Watchdog Timer, Conflict, or Voltage) shall remain triggered until reset by the Front Panel Control Switch or by the External Test Reset Line."

A c) Amend Last Sentence under Subheading 7.3 which starts "Power failures of duration..." to read:

"The Watchdog Timer shall deactivate when the Incoming A.C. Line Voltage falls below  $96(98 \pm 2)$  Volts A.C. for 50 milliseconds or more and shall become active when the Incoming A.C. Line Voltage rises above  $101(103 \pm 2)$  Volts A.C. for 50 milliseconds or more."

N 16. CHAPTER 3, SECTION IV, MECHANICAL REQUIREMENTS, Heading 3.

Amend Sentence One to read:

"The dimensions of the monitor module shall be as shown on the Plans."

N 17. CHAPTER 4, SECTION I, GENERAL.

Amend Sentence Two of Paragraph Two to read:

"The method of detection shall be based upon a design that shall render detection when a conductive metallic mass entering a loop causes a change of 0.02 percent in detector input inductance."

N 18. CHAPTER 4, SECTION II, FUNCTIONAL REQUIREMENTS.

Amend Heading 3.3.2 to read:

"With the detector channel in its most sensitive setting, the presence of a vehicle in the zone of detection shall be detected a minimum of three minutes for a vehicle causing 0.02 percent inductance change and a minimum of ten minutes for a vehicle causing 0.60 percent inductance change."

- A 19. CHAPTER 5, SECTION III, Heading 2: Add "Pin B with Function +24VDC".

- N 20. CHAPTER 7, SECTION II, Heading 1.7.

Add the following Sentence:

"Power Failure or Restoration shall not cause a channel output to the controller unit."

CHAPTER 7, SECTION III, Heading 3.

Amend Pin Assignment functions for Pins A, B, and C to read:

"NC (not connected)."

- N 21. CHAPTER 8, SECTION I, Heading 2.

Amend Sentence One to read:

"The overall physical dimensions of the switch pack shall be 7-3/8 inches  $\pm$  1/8 inch from the plug connector surface to the front panel of the switch pack (Location of indicators)."

- N 22. CHAPTER 9, SECTION IV, Heading 1.

Amend to read:

"The dimensions of the Flasher Unit shall be the same as Model 200 Switch Pack."

23. Under CHAPTERS 11 and 12, SECTION I.

- A a) Heading 3.2 Amend hours exposure from "350" to "336".

- N b) Add under Heading 3.3 the following:

"Tests shall be in accordance to California Test Method 645 except that the 180 Degree Bend Test does not apply."

- N 24. Under CHAPTERS 11 and 12, SECTION III.

- a) Amend CABINET ACCESSORIES to read "CABINET ASSEMBLIES".

- b) Add under Heading 1.1 "...and isolators."

c) Amend Headings 2.3, 2.4, 2.5 and 2.7 to read:

"2.3 Pins D, E, F, J, K, L and W on each edge connector slot shall be terminated on its associated Terminal Block mounted on the rear of its Input File. Pins F and W per slot shall connect to the proper controller unit inputs in Connector CIS Harness. Output emitters, Pins H and X, shall be commoned and brought out to T15-4 as shown on attached detail.

2.4 Positions D, E, J and K for each slot shall be wired to their appropriate Field Terminals as called out on the plans.

2.5 The input file shall be connected as shown on the plans. Note details on plans and addendums.

2.7 The card guide shall begin between 1/2 to 1-1/2 inches back from the front face of the file."

NOTE: In lieu of this method an option called out under Input Panel and shown on attached detail may be substituted.

N 25. CHAPTER 11, SECTION III, Heading 3. Power Distribution Assembly.

a) Amend Sentence Two of Paragraph One, Heading 3.1, to read:

"The depth of the assembly shall not exceed ten inches from the front cabinet rails including Terminal blocks."

b) Under Heading 3.2, Equipment Listing, amend "2 - Flasher Socket" to read: "2 - Flasher Socket and Model 204 Flasher Unit".

N 26. CHAPTER 11, SECTION III, Heading 4. Output File.

a) Amend Sentence Two of Heading 4.2 to read:

"Four flash transfer relays and One Model 210 Monitor Unit shall be furnished with each Output File."

b) Amend Heading 4.4 to read:

"Switch pack, monitor unit, flash transfer relay sockets and flash programing connectors shall be accessible from the back of the file without the use of tools."

c) Add under Heading 4.7 the following:

"Plug Pins shall be crimped and soldered."

N 27. CHAPTER 11, SECTION III, Heading 5, Flash Transfer Relay.

a) Amend Heading 5.1 to read:

"Flash transfer relays shall conform to the requirements for Model 430 Heavy Duty Relays."

b) NOTE: Option to One Line Diagram on attached detail. This option, if exercised, will affect Heading 5.3.

N 28. CHAPTERS 11 and 12, SIDE PANELS.

The following Option to the requirements for detector Terminals and Cable called out in these specifications for the Input Panel and between Panel and File is allowed.

"In Lieu of TB2 through 9 Terminal blocks and the associated cable to the Input Files, a fiberglass or plastic Raceway shall be provided as shown on the attached detail. Raceway and position of mounting shall be approved by the State before production."

29. CHAPTERS 11 and 12, SECTION IV, CABINET WIRING.

A a) Amend Heading 1.1 to read:

"1.1 Conductors in the controller cabinet between the service terminals and the signal bus breakers, including Chassis Ground Conductor to Power Distribution Assembly, shall be No. 8 or Larger."

N b) Insert ",Input File Slot Terminals," between "detector field conductors" and "auxiliary field wires" under Heading 2.2.

N c) Substitute "at 600 Volts" for "at 1,000 Volts" in Paragraphs One and Three of Heading 2.4 (Heading 2.6 in Chapter 12).

N 30. CHAPTER 12, SECTION III, Heading 3.7.

Delete Last sentence beginning "Power failures of 50 milliseconds..." and add the following:

"The Watchdog Timer shall deactivate when the Incoming A.C. Line Voltage falls below 96(98+2) Volts A.C. for 50 milliseconds or more and shall become active when the Incoming A.C. Line Voltage rises above 101(103+2) Volts A.C. for 50 milliseconds or more. The Watchdog Timer once triggered shall remain in a triggered state until reset by power restoration."

- M 31. Add the following specification under Chapter 12, Section V, Miscellaneous:

"Visual Alarm Light

A vandal resistant visual alarm light shall be mounted on roof of the cabinet as shown on the plans. The light shall be actuated by one of the switch pack outputs and by the transfer relay as shown on the plans. The light shall be visible from 360 degrees, shall be waterproof and corrosion resistant, shall have a blue acrylic plastic lens and shall be provided with a 120V, 15 to 20 Watt incandescent candle-base lamp. Lens cover shall be 2.5 inches in diameter and 1.75 inches in height maximum. The fixture shall be secured to the cabinet with a minimum of two screws."

- N 32. CHAPTER 14, I. MODEM

- a) Amend Heading 1.3.6 to read:

"1.3.6 Tone Carrier Frequencies: 1200 HZ and 2200 Hz with +1 percent tolerance."

- b) Amend Heading 1.3.9 by adding "(1000-2400 Hz)" after "operation band".

- c) Amend Headings 1.3.11, 1.3.12 and 1.3.14 to read:

"1.3.11 Carrier Response Time: 8+2 milliseconds

"1.3.12 Soft Carrier (900 Hz) Turn Off Time: 10+2 milliseconds

"1.3.14 Error Rate: not to exceed one bit in  $10^5$  bits with a signal-to-noise ratio of 16 db with noise flat weight over a 300 to 3400 Hz band."

33. Add the following specification:

SPECIFICATIONS FOR SYSTEM MEMORY MODULE

MODEL 412

This specification defines the specifications applicable to the Model 412 SYSTEM MEMORY MODULE. These specifications shall supplement the General Specifications for Traffic Signal Equipment and in case of conflict the specifications of this specifications shall govern.

SYSTEM MEMORY MODULE

1. The module shall comply with the details and connections shown on the plans for Model 170 Traffic PROM Module.

















2. All electrical connections in and out of this module shall be through a printed circuit connector having two rows of 36 independent bifurcated contacts on 0.100 inch centers.
3. The module shall be designed so that persons inserting or removing the assembly shall not be required to insert hands or fingers within the microprocessor unit housing this modular assembly. A handle or gripping device protruding no more than 1-1/4 inches from the front panel shall be attached to the front of the assembly. The front panel shall be connected to ground.
4. All Data Inputs and Outputs shall be Tri State Buffered enabling them to drive a load consisting of 10 TTL gates and 200 picofarads. When this module is not being addressed, the data output and input shall be disabled into a high impedance state and the data I/O lines shall not source or sink more than 100 microamperes. All address inputs shall not load the bus by more than one TTL gate load and 100 picofarads.
5. The memory shall consist of a minimum of 16,384 eight-bit words of PROM, mounted in four associated sockets and 8,192 eight-bit words of STATIC RAM. RAM Memory used shall be approved by the State.
  - 5.1 Each PROM (located at address C000 to FFFF) chip shall be electrically programmable and erasable by exposure to ultraviolet radiation. This memory shall be nonvolatile and shall not be affected by transients resulting from power switching and external loading and unloading conditions. The PROM chips shall be Texas Instruments TMS 2532 or equivalent.
  - 5.2 The static RAM (located at address A000 to BFFF) shall not be affected by transients resulting from power switching and external loading and unloading conditions.
6. The MODULE shall operate and intermate with the Model 170 Controller Unit.
7. The front panel of the module shall be labeled "SYSTEM MEMORY MODULE MODEL 412".
8. The module shall correctly respond to a state test program.

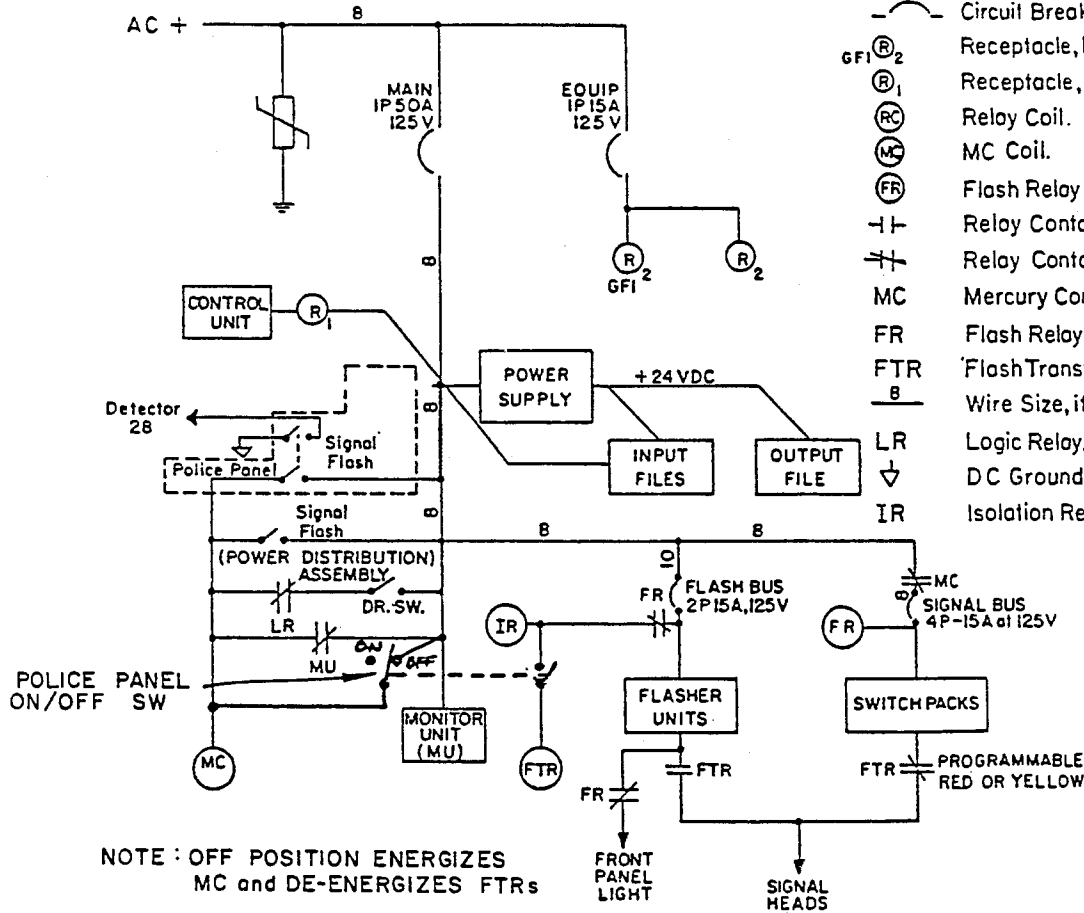
N - November Addendum

A - August Addendum

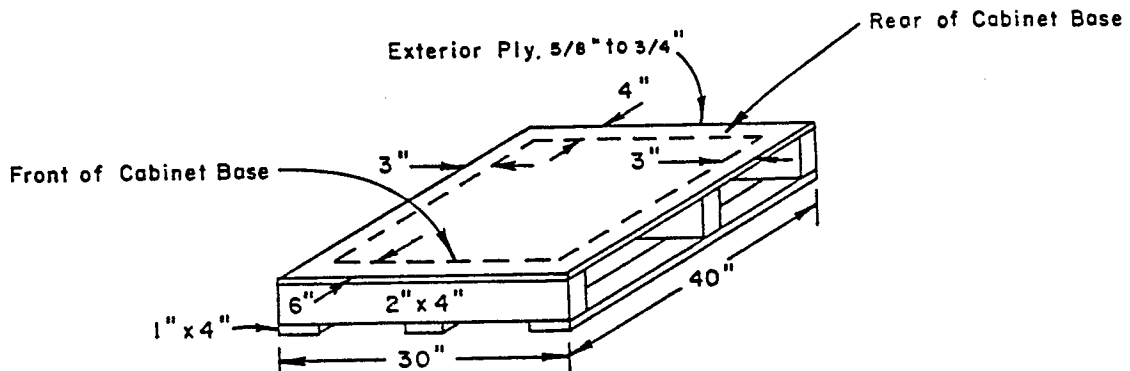
M - May Addendum

# LEGEND

-  Surge Protector
-  Circuit Breaker.
-  Receptacle, Duplex; Ground Fault Interrupter
-  Receptacle, Single
-  Relay Coil.
-  MC Coil.
-  Flash Relay Coil.
-  Relay Contact N.O.
-  Relay Contact N.C.
-  MC Mercury Contact
-  FR Flash Relay
-  FTR Flash Transfer Relay.
-  Wire Size, if not indicated shall be #14 AWG
-  LR Logic Relay, Output File
-  DC Ground.
-  IR Isolation Relay, Output File



ONE LINE CABINET DIAGRAM - OPTION #1

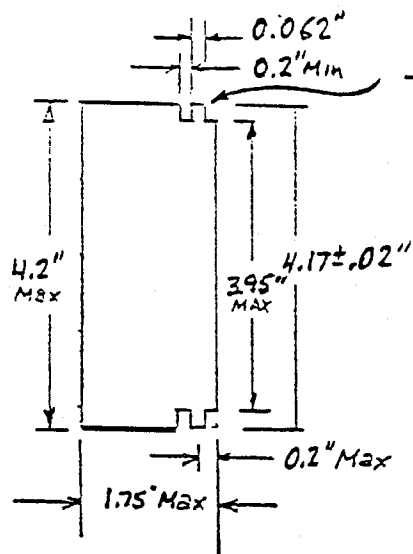


NOTE: Dashed lines delineate positioning of cabinet on pallet

CABINET PALLET

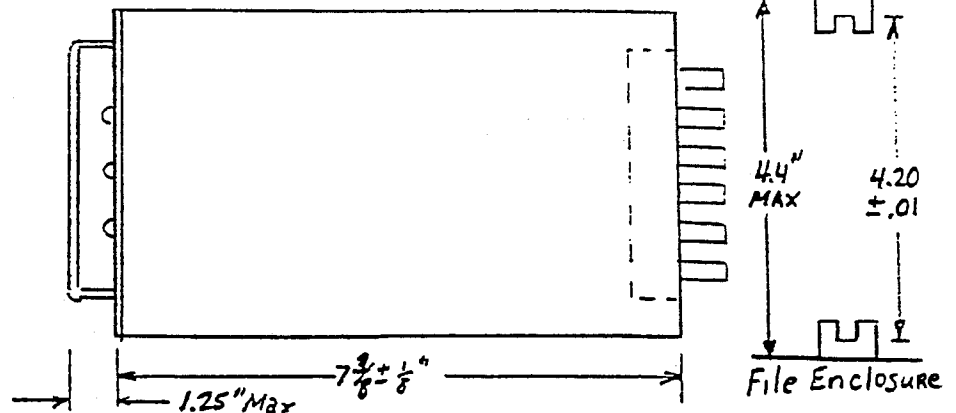
ADDENDUM DETAIL #1





## MODEL 200 SWITCH PACK

Enclosure and  
Edge Guide

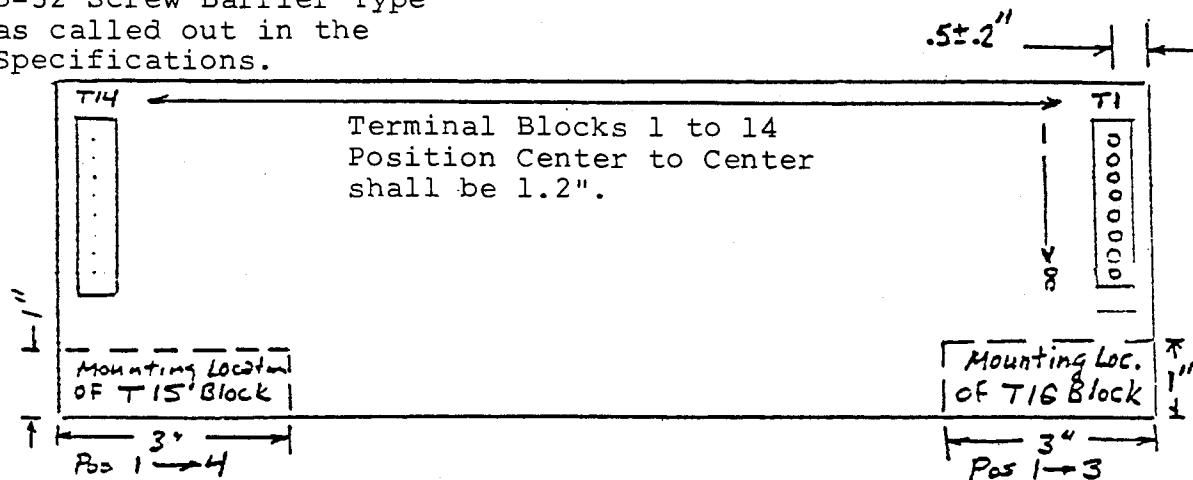


Switch Pack Cross Section

Switch Pack Side View

NOTE: Terminal Blocks  
T1-14 shall be  
mechanically  
supported to the  
chassis of the File  
and shall be 8 Position  
8-32 Screw Barrier Type  
as called out in the  
Specifications.

## INPUT FILE DETAIL



### T1-14 POSITION ASSIGNMENT

Pos	Pin - Function
1	SP - Spare
2	F - Ch 1 Output
3	W - Ch 2 Output
4	D - Ch 1 Input
5	E - Ch 1 Input
6	J - Ch 2 Input
7	K - Ch 2 Input
8	L - Eq GND

### T15 POSITION ASSIGNMENT

Pos	Function
1	+24 VDC
2	DC GND
3	Det Reset
4	CTR GND

### T16 POSITION ASSIGNMENT

Pos	Function
1	AC+
2	AC-
3	Equip GND



USER'S COMMENT SHEET

Report Title: \_\_\_\_\_

Report Date: \_\_\_\_\_ Date of This Letter: \_\_\_\_\_

User's Name: \_\_\_\_\_ Telephone: (    ) \_\_\_\_\_

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Location in Manual

Error/Comment/Suggestion

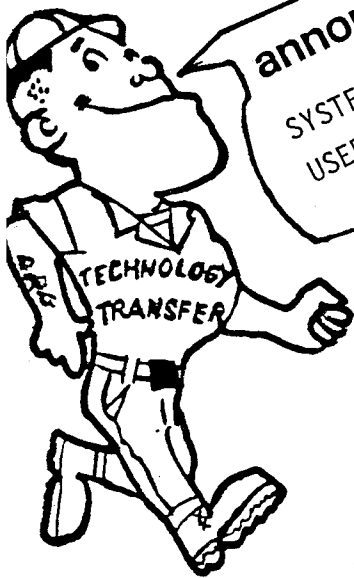
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